DECEMBER 18, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

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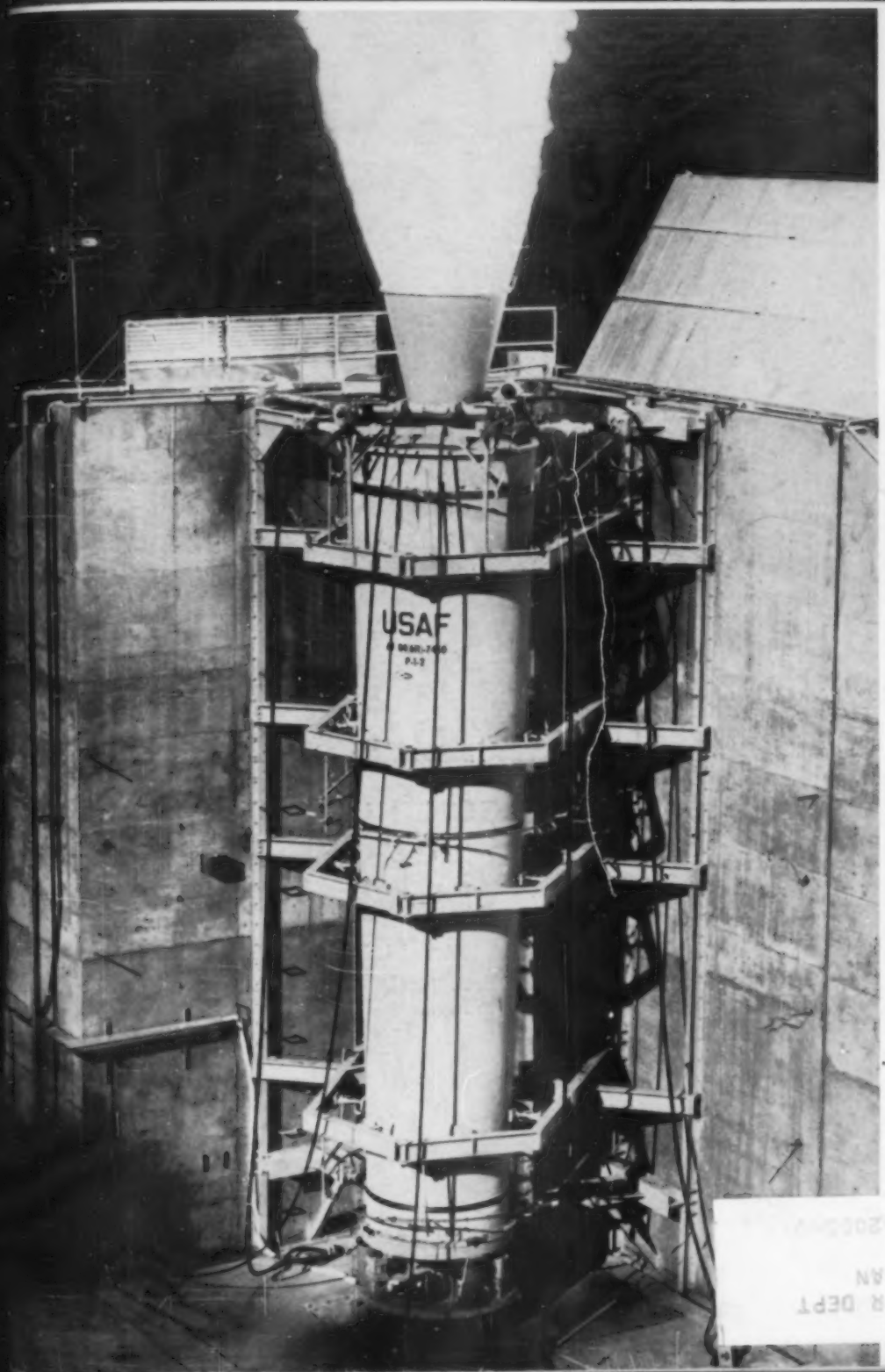

Boeing Wins Big Award for Saturn S-IB Stages

- NASA Buying 2-Man Mercury
- Minuteman Build-up Looms
- Details of Cape Complex 37

UTC Fires 100-in. Segmented Solid

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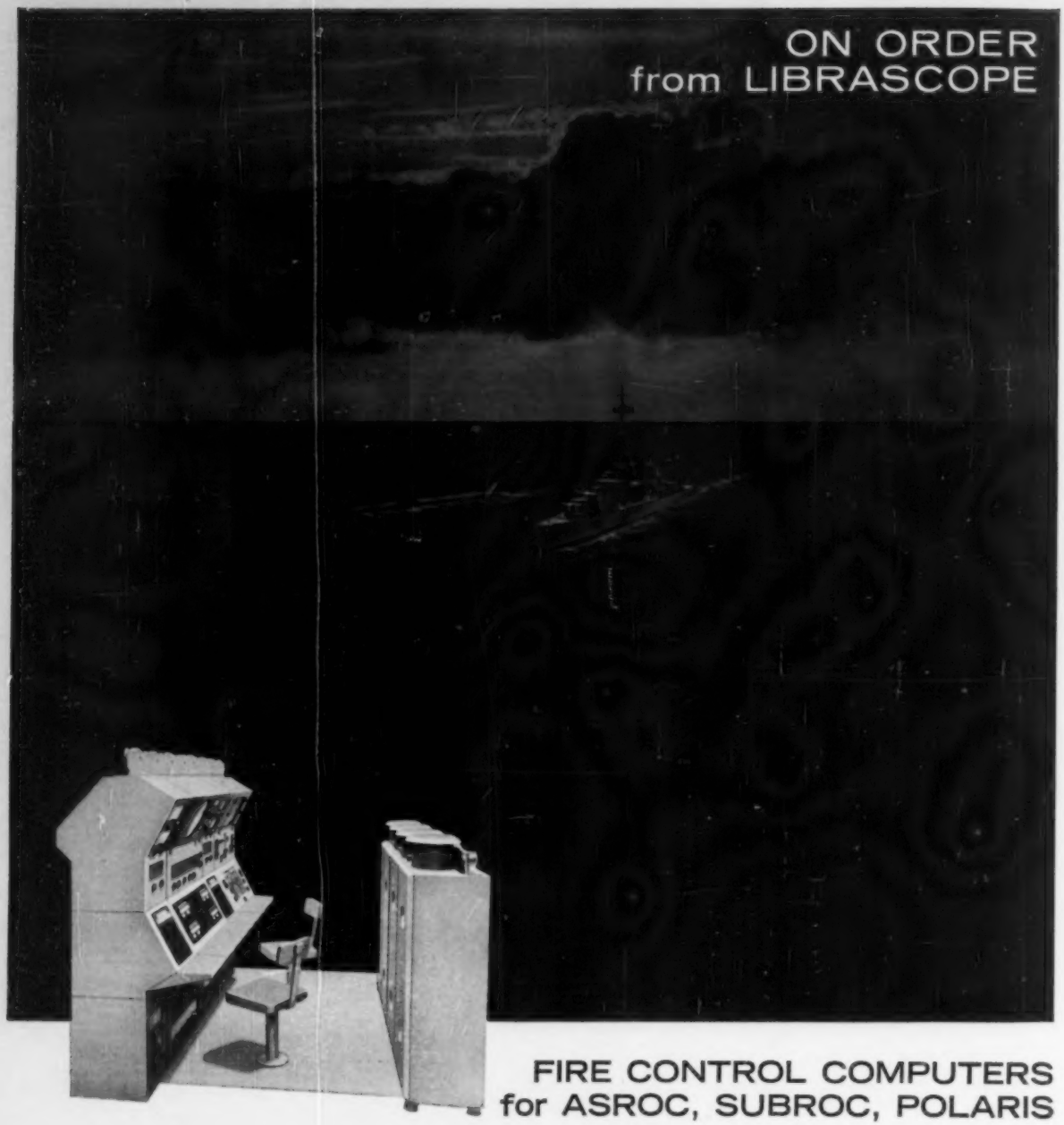

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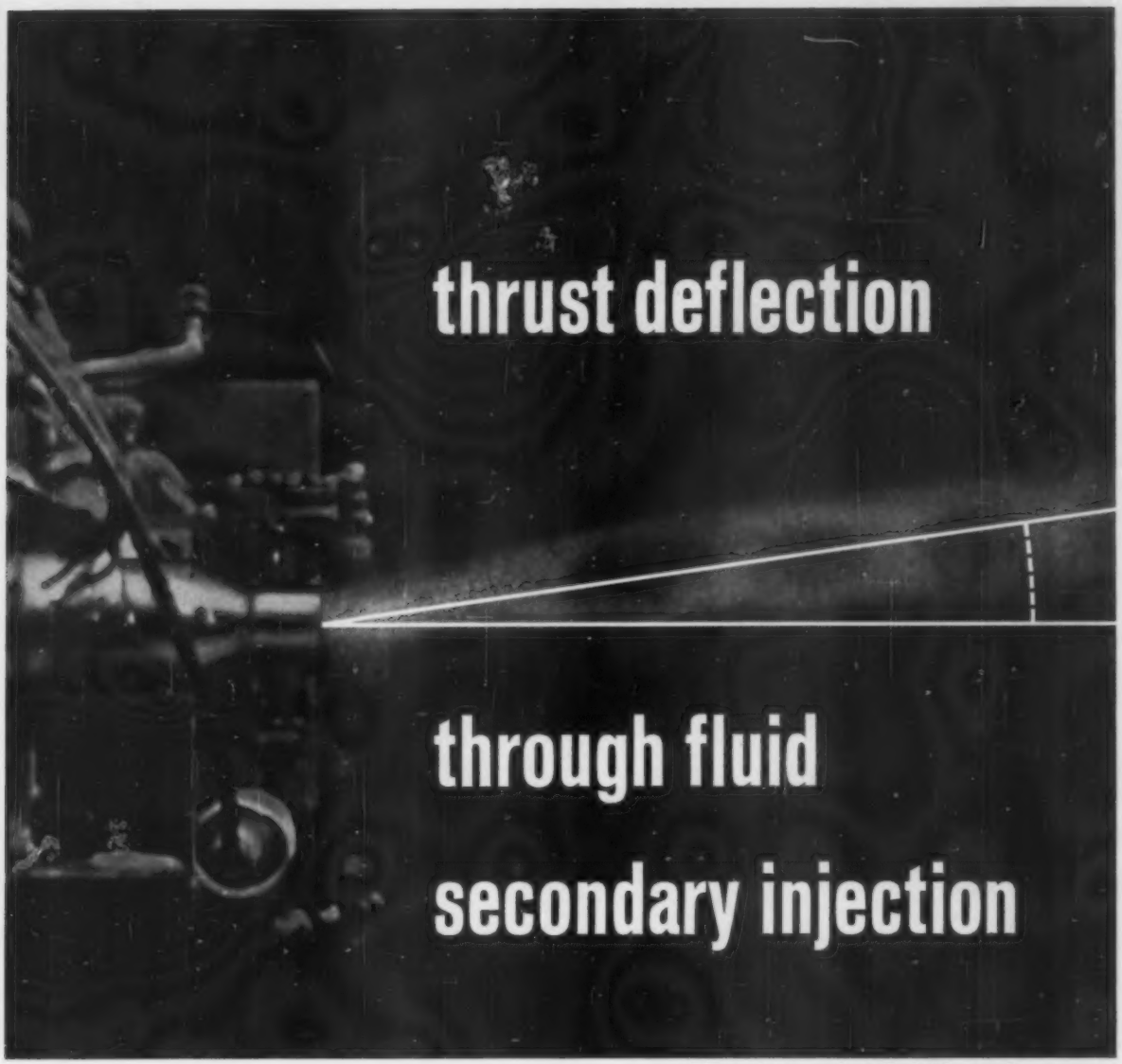

Photo of test conducted at AiResearch

AiResearch is now conducting laboratory tests utilizing various fluids in secondary injection systems for missile thrust vector control.

These tests show many advantages over present vectoring methods; faster response, moving parts are virtually eliminated, and high temperature problems are minimized. In addition, the average vectoring system weight is less as the fluid is expended at burn-out.

AiResearch, with many years of experience in systems management, research and production in the components involved, is prepared to help solve your steering and vector control problems. Direct requests for information to the Los Angeles division.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 25 December 18, 1961

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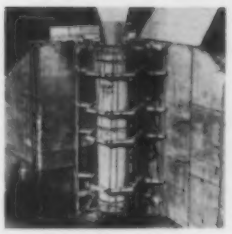

THE COVER

Successful firing of United Technology Corp.'s 100-in. segmented solid booster. Pentagon is about ready to ask for proposals on 120-in. solid booster. *See p. 15.*

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†U.S. Reg. Pdg.

M/R publishes 51 times a year. Readers are reminded that there will be no magazine on Dec. 25.

Season's Greetings—The Editors

38,413 copies this issue

TODAY'S DEFENSE SYSTEMS:

Worth more & why

In today's defense arsenal, things cost more. They cost more because they are worth more. They do jobs undreamed of a few years ago—with reliability never believed possible. Jet fighters are flying higher and faster. New atomic-powered ships carry enormous strike power. Missiles are thrusting farther with greater accuracy. And new electronic systems, like the Hughes Tactical Attack System, are making "impossible" control jobs a daily routine.

Hughes systems, developed to meet the most advanced fighter mission problems, have paced airborne systems development. They have flown with the F-86, the F-89, the F-102, the F-106, and other U.S. Air Force, U.S. Navy and Canadian aircraft.

The new Hughes Tactical Attack System in its own right achieves new levels of capability, reliability and over-all economy. Highly flexible in design, this new system will be as modern in the late 1960's as it is today. It integrates three major functions—high resolution radar, weapon control auxiliaries and a navigational subsystem. Each function incorporates the latest state-of-the-art developments.

Coolant Problems which could be encountered in aircraft flying at multiples of sonic speeds and at high altitudes have been solved. New techniques are being applied which provide for more efficient cooling of the thousands of electronic parts and assemblies, promising greater reliability.

New "encapsulation" packaging techniques permit more work to be done in smaller space, saving weight and, again, vastly increasing reliability. This technique packages complex circuits in small "blocks" of plastic material. Each contains scores of diodes, transistors, relays and other electronic components. These units are vibration-free. They can be plugged in and out as easily as a toaster—facilitating trouble-shooting and cutting maintenance time.

These kinds of advancements are the "norm" at Hughes. For they are the result of over 16 years of prime experience in the design and building of airborne systems. The new Hughes Tactical Attack System has grown out of a special, company-funded program which has been active for three years.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

An important part of Hughes airborne systems capability is the company's background in field service and support functions. This work, involving seven major systems, helped in the development of the unique self-test features incorporated in the new Hughes Tactical Attack System.

Better today, better tomorrow. The Hughes Tactical Attack System, like other major new defense systems, is worth more simply because it delivers more—in actual hardware capability *and* in the skills and facilities that back its success.

(1) Hughes Tactical Attack System has all the features and technical advancements necessary to the mission.

(2) Hughes has one of the Free World's most efficient electronics manufacturing capabilities.

(3) Hughes engineers draw on experience gained in the design of systems for more aircraft than any other group.

(4) Hughes Field Engineers have worked with more than 16,000 airborne control systems.

(5) The Hughes system will not become obsolete before it flies. Rather, it is presently designed to keep step with improved aircraft performance and more demanding mission requirements.

memo from the publisher

MICHAEL GETLER
Covers New York-New England.

ARTHUR H. COLLINS
Joins West Coast bureau.

SOME WEEKS AGO, we mentioned our plans for putting together a strong electronics editorial team which would provide expanded coverage of this important sector of the missile/space industry.

In anticipation of this, Electronics Editor Charles D. LaFond was named a senior editor. We now are pleased to announce the appointments of the other members of the team.

After more than a month's training here in our Washington headquarters, Electronics Editor Michael Getler has reported for duty in our New York office. Mike will handle coverage of the important New York-New England area.

He comes to us with an excellent background for the job. For the past two years, Getler has been a reports writer for Raytheon's Missiles and Space Division at Bedford, Mass. There, he was engaged in writing and preparing technical reports on the company's research, development and flight-testing efforts in the guided missile field, particularly on the *Sparrow III* program. His work there, demanding close liaison with project engineers and an accurate translation of their complex activities onto paper, makes him well qualified for his new post.

Before joining Raytheon, Mike put in three years of commissioned service with the Navy, serving as an airborne air controller with a carrier-based AEW squadron. He holds the rank of Lieutenant in the Naval Reserve.

Prior to his Navy service, Getler was assistant editor of the Riverdale Press, a prize-winning New York City weekly newspaper. He is a graduate of City College of New York, where he finished in the top third of his class.

Mike and his wife, Sandra, and their two children, Belinda and Warren, are city dwellers. A Riverdale apartment is home to them.

THE OTHER new member of our nationwide electronics team is Electronics Editor Arthur H. Collins, who has reported for duty in Los Angeles.

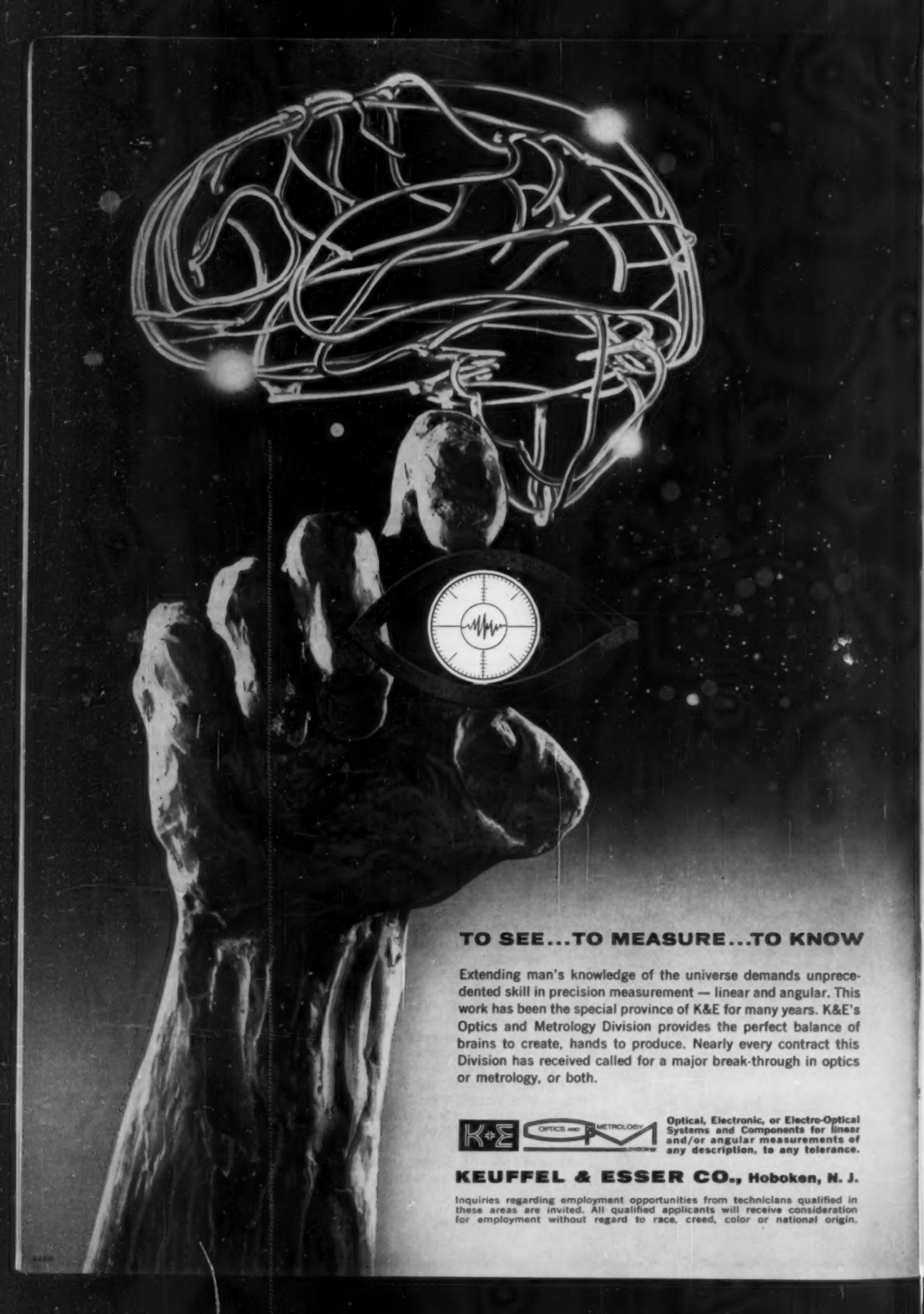
Art comes to us from another highly regarded electronics firm, the Librascope division of General Precision, Inc. He was an engineering writer and later served as Publications Engineer for Librascope's Aerospace Branch.

Collins received his Bachelor of Science degree in Electronic Engineering from Pacific States University in 1960. Before that, four years in the Air Force gave him a thorough grounding in electronics. He was graduated from three electronics technical schools and was an electronics instructor in the Air Training Command. He helped set up the Airborne Navigation Equipment School at Scott Air Force Base, Ill., in 1955. Art was assigned in 1956 to the training aids division at Keesler AFB, Miss., for research and development on a computer simulator for the SAGE system. He later was transferred to Hanscomb AFB, Mass., on the same project. In 1957, he received the Commendation Award from the Secretary of the Air Force for his part in the development of the SAGE system simulator.

Art and his wife, Nancy, live in Los Angeles. One of his hobbies is wild animal training, and their house pet is somewhat unusual: a 40-lb. South American ocelot!

We think our new fulltime electronics editorial team will make quite an impact on our electronics coverage. Watch for it during 1962.

Edward Michelfeld



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The Countdown

WASHINGTON

DOD's Budget: Last-Minute Adjustments

As the Kennedy Administration's FY '63 budget moved toward the printer, "sudden death" became a disease afflicting several major programs. Mobile *Minuteman* disappeared without a trace (see page 12). All funds for *Nike-Zeus* production—an estimated $300 million to $400 million—were reported to have vanished, at least for the present. However, the already cut request for additional *Polaris* submarines held its ground. The budget is still expected to call for about six more submarines and long-lead items for another six.

The Nike-Zeus Game

The elimination of production money for the *Zeus* anti-missile missile from the FY '63 defense budget is not looked upon as a disastrous defeat by many of its Army supporters. The inclusion of the production money always was a phony because none of the money could have been spent until next summer. Therefore, if production money is added sometime later, after final *Zeus* tests in the Pacific begin, little will have been lost. Deployment still will have slipped another six months.

Centaur Continues To Skid

The first launching of the *Centaur* upper stage is now expected to come in late January at the earliest—and most likely in February. NASA officials say the new earliest target date for the launching is Jan. 29. Originally, the launching was to come around October. Technical problems have interfered.

From Eagles to Eaglets

A Navy study program is reviving the moribund *Eagle* program in the form of *Eaglet*. Essentially the *Eaglet* is understood to be a cut-down air-to-air *Eagle* missile probably designed for launching from the new TFX interceptor.

Astronauts in Mufti

Plans for NASA's follow-on *Mercury* program call for including some civilians in the next group of astronauts to be trained. The *X-15* program is considered to be a likely recruitment area. So far, there is no decision on just how many new astronauts will be needed.

Final U.S. ICBM Muster for '61

SAC's total operational ICBM force stands at 54 *Atlases*. The last *Atlas* squadron to be added this year—nine missiles in "Hollywood hard" launchers at Warren AFB, Wyo.—quietly became operational Dec. 12. No *Titans* are now expected to be added to the ICBM force until early spring.

INDUSTRY

FABMIDS Dilemma

COUNTDOWN hears the Army is debating whether to write some new *FABMIDS* (field army ballistic missile defense system) specs and reopen the bidding. General Electric won the competition on the original specs. Three of the six entrants met the original specs—the remaining three decided they could be shaded, particularly in regard to 360° radar. Result: three heavy, three light entrants.

R&D Intelligence

A hydrogen gas-bearing gyro developed by Sperry Gyroscope Co. is expected to triple the accuracy of SINS inertial navigator systems for *Polaris* submarines . . . Exploding bridge wire approach is being studied as a possible replacement for mine-type sonobuoy detection method in ASW . . . National Science Foundation and Office of Naval Research balloon studies of electron "dumping" (influx of electrons from the Van Allen belts to the earth's atmosphere) are expected to continue for some time.

Apollo Rendezvous Contracts Coming

NASA is planning to let contracts by mid-1962 to determine the electronic requirements needed for *Apollo* rendezvous missions. The contracts will cover the rendezvous in orbit of *Apollo* spacecraft with advanced *Saturn* vehicles.

British to Share AUTEC

The British are expected to join the United States in using the Navy's planned Atlantic Underwater Test and Evaluation Center—the new AUTEC Missile Range—in the Bahamas. The range is being established under agreements still to be signed with the United Kingdom. Initially, at least, all construction costs will be met by the United States.

INTERNATIONAL

New Skybolt Launcher?

Britain's Royal Air Force is considering a military version of the VC-10 jet transport as a platform for lauching *Skybolt* ALBM's. The VC-10 could carry eight *Skybolts* . . . It's also reported that the RAF for the first time in England launched an inert *Skybolt* from a Vulcan bomber. The recent test occurred over a range at West Freugh in northern Scotland.

NATO Defense Spending Up

Fifteen NATO nations spent $67.8 billion—an all-time high—for defense in 1961. The figure was up $5.5 billion over last year and includes $51 billion spent by the U.S.

Overseas Pipeline

The British Army is adopting British Aircraft Corp.'s *Vigilant* antitank missile . . . Nord's *C.T. 41* solid/ramjet target drone was successfully flown for the first time Dec. 13, reaching 35,000 ft. above the Colomb Béchar range in North Africa . . . Propellant for the European space booster *(Blue Streak)* upper stages is now expected to be UDMH and nitrogen tetroxide . . . Russia is understood to be working hard at orbital rendezvous.

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The Missile/Space Week

Soviet ICBM Force To Hit 200 by 1963—NATO Says

A NATO intelligence report estimates that Russia will have deployed some 200 ICBM's by the end of next year.

The same report also estimates that the Russians today have about 20 missile-launching submarines of which about four are nuclear-powered.

However, the report says that the Soviet missile subs can launch their missiles only while surfaced.

The statement regarding Soviet missile subs jibes generally with other reports. However, it is one of the hardest to date regarding the Russian nuclear submarine force.

Khrushchev Boasts Stockpile Includes 100 MT-Plus Bombs

Soviet Premier Nikita Khrushchev last week claimed that Russia is stockpiling nuclear weapons more powerful than 100 megatons each.

Moreover, Khrushchev warned that his *Vostok* spacecraft could deliver the super bombs to any point on earth.

"I am not threatening," he shouted. "But I am warning you (the Western Powers) that if you want to test the Socialist countries by war you will never see the end of socialism as you will never see your own ears."

McNamara Urges Build-up Of NATO Conventional Arms

Defense Secretary Robert McNamara issued a new plea to the European members of NATO to increase the size and power of their conventional military forces.

McNamara stressed the same theme throughout much of a meeting of NATO ministers at Paris.

He said NATO must close the existing gap between its nuclear power and its ability to fight conventional wars.

Sixth Nuclear Test in Nevada

The AEC detonated the sixth announced underground nuclear test in its current series this last week.

The test—conducted at the AEC's Nevada proving ground—was listed as "low yield."

Meantime, officials involved in the test program are reported to be finding the test results not as satisfactory as expected—and the need for atmospheric tests greater than previously believed.

U.N. Space Group To Meet

The U.N. Committee on Peaceful Use of Outer Space has finally gained Soviet agreement to hold its second meeting. The date: March 31.

The agreement immediately aroused congressional suspicions. Chairman John C. Stennis of the Senate Preparedness Subcommittee warned that the United States must not let itself be "lulled into a moratorium on outer space development."

Shots of the Week

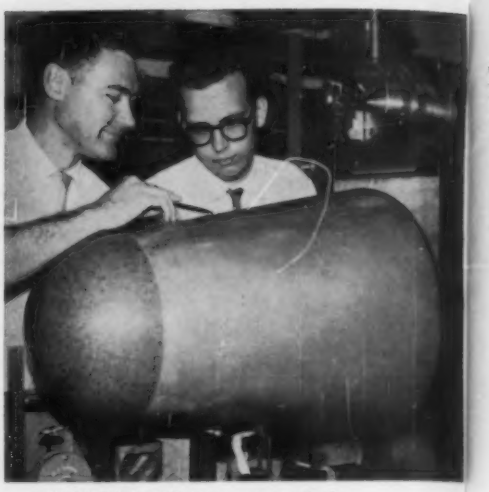
The Air Force wound up the *Titan I* R&D test-flight program Dec. 13 with a 5000-mi. shot from Cape Canaveral.

First flight of the ICBM was on Feb. 6, 1959, and was successful. There have been a total of 40 *Titan I* shots—four classed as failures, eight as partial successes and the rest successful.

More flights of the Martin Marietta *Titan I* are scheduled from the Cape to test components for *Titan II*.

In other shots:

- The Air Force's *Discoverer XXXVI* was orbited from Vandenberg AFB Dec. 12. It carried a capsule intended for recovery and a 10-lb. piggyback satellite, *Oscar* (orbiting satellite carrying amateur radio), to beam signals to ham radio operators.
- An *Atlas F*, in another piggyback experiment Dec. 12, released a package of 28 dummy atomic fuel cells made of sodium, potassium, rubidium and cesium in a study of how metals evaporate on re-entry. The shot was from the Cape.
- A *Nike-Zeus* passed an extended flight test in the atmosphere Dec. 14 from Pt. Mugu, Calif. It glowed red-hot while going through severe guidance maneuvers.
- A *Trailblazer II* rocket was launched Dec. 14 from Wallops Island by a team from Atlantic Research Corp., designers of the rocket. The four-stage vehicle drove a General Electric re-entry capsule down through the atmosphere from 190 miles altitude. The launch was the first of several re-entry physics experiments sponsored by NASA, MIT's Lincoln Laboratory and ARPA.



TRAILBLAZER II re-entry vehicle.

NAA Sets Up Apollo Division

North American Aviation's Space and Information Systems Division will form a new Apollo Division to handle its multibillion-dollar contract for the U.S. manned lunar landing program.

Vice President and General Manager John Paup will direct the new division. He will be aided by Milton Sherman, Assistant Program Manager, and C. H. Feltz, Chief Engineer.

The Division will also have a program management control unit headed by C. W. Warden.

PERT program control techniques will be utilized by this office, as will other computer-type management techniques.

R. S. Risley will serve as assistant program manager for contract relations.

NASA will set up a liaison office at the division with a staff of about 20 people. In return, NAA will open an office at the space agency's Manned

Spacecraft Center in Houston.

Engineering offices will also be set up for various specialty areas including Flight Technology, Ground Support Equipment, Design and Structures, Reliability Design and Crew Safety, Project Integration, Power Systems, Space Electronics, and Bioastronautics.

Explorer's Van Allen Data

Explorer XII satellite has discovered the outer Van Allen Radiation belt's constituent is protons, not neutrons as was previously believed.

NASA also disclosed that the satellite—launched on Aug. 15, 1961—stopped transmitting recently after 112 days in orbit. A malfunction in the primary power system was blamed for the failure.

Besides reporting that there are a thousand times fewer neutrons in the outer belt than was previously thought, the satellite sent back to earth more than 3 billion bits of information. It is expected to take until mid-1962 to analyze the more than 2500 miles of tape data. Project scientist Dr. Frank McDonald, of NASA's Goddard Space Flight Center, said that the satellite also sent back important information concerning the design of solar-powered satellites which have to traverse the radiation belts.

TRAAC Assuming Attitude

Partial activation of the gravitational stabilization experiment aboard the Navy's *TRAAC* satellite (M/R, Nov. 27, p. 29) may have been accomplished.

Tracking stations report that the vehicle appears to be slowly stabilizing into approximately the predicted earth-oriented attitude. It will be 2-3 weeks before results are known.

APL scientists triggered the device aboard the satellite on Nov. 24. It was to have released a weight and boom arrangement causing the craft to direct one face towards earth at all times. The signal indicating completion of the boom extension was not received at ground stations. Scientists speculate that the failure was due to a mechanical breakdown in the small activating motor. However, partial release of the stabilization equipment is indicated by the slow movement into the prescribed attitude.

S-48 Gear Checks Out

Ionospheric test equipment slated to go aboard the *S-48* satellite this summer performed well during two suborbital rocket rides, according to an analysis of data taken during the June and October flights by the National Bureau of Standards Radio Propagation Laboratory.

NBS, under NASA sponsorship, is participating in an international program aimed at collecting new information on ionospheric phenomena.

The instrumentation was carried aloft from Wallops Island, Va. by four-stage *Javelin* rockets to a peak altitude of about 600 miles. The payloads each remained above the ionosphere layer for about 14 minutes. The *S-48* vehicle, called a Topside Sounder, will remain operational above the ionosphere for from 6 to 12 months and will supply data on topside electron densities, ionization diffusion in the F-2 layer, vertical movements, tidal fluctuations, and properties producing ionospheric storms.

When in orbit, the *S-48* will transmit a pulsed radio wave down towards the upper layer of the ionosphere and telemeter the reflected signal to ground stations. This is basically the same method used in ionospheric measurements made from earth. Peak power requirements for top layer soundings are expected to be considerably below those needed from terrestrial sites.

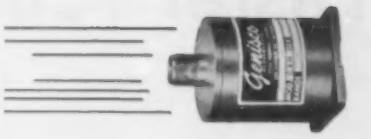
First Houston Contract Let

First step towards construction of NASA's new Manned Spacecraft Center in Houston was a $1.5-million architect-engineer award last week to Brown & Root, Inc., of Houston.

The contract, which will be supervised by the Fort Worth district of the Army Corps of Engineers, includes master planning for the complete installation, site development, design of the flight project facility, flight operations facility, equipment evaluation laboratory, and some utilities. Design engineering for the environmental test lab is not included in this initial contract.

Completion of the Houston firm's effort is expected in about six months, but letting of the first construction contract is anticipated in February.

SHOCK: TO 50 G



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Reacting to Russians? . . .

Faster ICBM Deployment Looms

Swelling of hardened Minuteman force, at expense of mobile Minuteman, may yield increase of 300 by July; total deployment of 1500 could result; Pentagon increasingly interested in development of MRBM, mobile ICBM

by James Baar

THE KENNEDY Administration is moving toward a new acceleration of ICBM deployment—apparently as a result of Soviet defense budget boosts.

The tip-off came in a last-minute Defense Department budget move on Dec. 13 killing the mobile *Minuteman* R&D program in favor of a considerable expansion of the authorized force of hardened and dispersed *Minutemen*.

The Soviets on Dec. 6 announced the second major increase in their defense budget in less than six months. Under the ruble-dollar detection and translator system used by many experts in deciphering Soviet military budgets, the new increase amounts to nearly $5 billion and the total increases over the last six months to $18 billion to nearly $20 billion.

The Soviet military budget for 1962 is now estimated to total nearly $60 billion. The U.S. defense budget for FY '62 is expected to total between $51 billion and $52 billion.

• **300 increase**—The total authorized *Minuteman* force is expected to be expanded to about six 150-missile wings —an increase of 300 missiles over the total authorized through FY '62.

No new production schedule has been completed so far. However, it is expected that the production rate and deployment rate will be increased considerably rather than merely extended.

Previous plans have called for deploying the first 600 *Minutemen* in hardened silos by about 1964. If site construction were started quickly enough, this number could be augmented in the same time period by one and possible both additional wings.

So far, deployment plans call for *Minuteman* wings at Malmstrom AFB, Mont.; Ellsworth AFB, S.D.; Minot AFB, N.D.; and Whiteman AFB, Mo. Soil borings for possible site construction have already been made at Reese AFB, Texas; Tinker AFB, Okla.; and Pease AFB, N.H. More soil borings are planned at Glasgow AFB, Mont.; Grand Forks AFB, N.D.; and Warren AFB, Wyo.

If all sites are used, total *Minuteman* deployment could reach 10 wings —1500 missiles.

No acceleration of deployment would have been possible with the mobile *Minuteman*. The program for putting the solid fueled ICBM on railroad cars has slipped badly over the last year because of budget cuts. At the time of its entombment it still faced a number of tough technical problems.

• **New mobile missiles**—However, the expansion of force levels was not the only consideration in the decision to kill the mobile *Minuteman*. Two other important factors were:

—The Pentagon's plans to develop a highly-mobile MRBM.

—Increasing Pentagon interest in developing a new, mobile ICBM.

Both new missiles, unlike *Minuteman*, would be designed to begin as mobile systems. Both would be based on the use of improved nuclear warheads which are expected to be developed and tested over the next year.

The double decision on *Minuteman* abruptly reversed earlier plans incorporated in the draft of the FY '63 defense budget. The mobile R&D *Minuteman* program was to be resumed after a stretch out of one year. No additional *Minuteman* wings were included despite strong Air Force objections.

To date, a total of $108 million has been spent on the mobile *Minuteman* program. The Eisenhower defense budget for FY '62 requested $220 million for the mobile program, but this was totally eliminated by the Kennedy Administration at the same time that the hardened and dispersed program was accelerated earlier this year.

The Kennedy budget revision also included $36 million to build standby production facilities for *Minuteman*. These facilities make it possible to double *Minuteman* production.

But, if maximum benefit was to be derived from the capability to double production, the Air Force made clear that the decision to use it had to be made earlier this fall in order to begin constructing more bases in time. Moreover, the Air Force has called for the deployment of more than 2000 *Minutemen* rather than the 900 now expected to be proposed.

The Kennedy Administration has been reluctant to accelerate the deployment of ICBM's further for fear that such a move would excite the Russians into increasing their ICBM deployment.

Also, the Administration has been having considerable difficulty in keeping the FY '63 defense budget under $52 billion. Accordingly, Administration officials have not been overly hospitable to arguments in favor of a greater margin of strategic security.

Apparently, it took the new Soviet defense budget and related ominous information to bring about at least a partial conversion. ⌗

First Two-Man Mercuries Next Year

Still-to-be-named project to test orbital rendezvous, cost $500 million or more.

by Hal Taylor

NASA EXPECTS to pour about $250 million in the next 18 months into its new two-man follow-on *Mercury* spacecraft. The first bell-shaped capsules are expected off the assembly lines late next year.

Last week NASA was still looking for a name for the new project—which will have a primary mission to test orbital rendezvous.

First flights are planned for 1963. If successful, some space agency officials believe two years can be cut off the 1967 target date for the manned lunar landing of an *Apollo* spacecraft —thus providing the U.S. with a chance to beat Russia to the moon.

It will also permit training for additional U.S. astronauts during one-week orbital flights and serve as a test bed for *Apollo* sub-systems and flight theories.

The program's total cost is estimated at $500 million, but it will probably be higher. Approximately 50 per cent of this is slated to go to McDonnell Aircraft Corp. — builder of *Mercury* — which NASA has selected as prime contractor.

Almost all of the remainder will go to General Dynamics/Astronautics, Martin Marietta Corp., and Lockheed Aircraft Corp., for the *Titan II*, and *Atlas Agena B* to be used as launch vehicles.

NASA officials report that $76 million is already allocated for the program in the next six months. McDonnell will get $40 million with the remainder split among the launch vehicle prime contractors.

• **12 capsules**—Another $200 million is expected to be earmarked for the program in the space agency's fiscal 1963 budget. The $500 million estimate for the total cost of the program includes about 12 spacecraft, plus *Atlas Agena* and *Titan II* launch vehicles.

The NASA announcement of the new program Dec. 7 confirmed M/R exclusive reports that it was coming (10/9/61 p. 16; 10/16/61 p. 17; and 12/4/61 p. 14).

The new program originates in a proposal from McDonnell and a NASA desire to test orbital rendezvous and the reactions of astronauts to the rigors of one week space flight—the same length of time involved in going to the moon and back.

The new spacecraft will be the same shape as the current *Mercury* capsule but will be far larger and much more sophisticated. It will be able to return to land instead of water, use a glide wing during re-entry and will have ejection seats for low-altitude astronaut escape besides being equipped for rendezvous docking operations. The most significant changes from the *Mercury* capsule include:

• **Size**—It will be 1 ft. larger than the current 74 in. base of the *Mercury* capsule and it will be lengthened proportionately to provide a 50 percent increase in cabin space.

• **Weight**—It will be two to three times as heavy as *Mercury*, weighing about 4000 lbs. during its early flights and 6000 lbs. during the rendezvous flights.

• **Boosters** — Martin Marietta Corp.'s *Titan II* vehicle will be used to put the spacecraft into orbit. Its second stage will be uprated from 15,500 to at least 17,500 miles per hour. General Dynamics/Astronautics' *Atlas* missiles will place *Agena B* vehicles into orbit for the rendezvous attempts with the spacecraft.

• **Propulsion** — Six variable-thrust engines—two for each axis—will be used for maneuvering during orbit. The propellant will be hypergolic—hydra-

(Continued on next page)

Saturn S-IB Contract May Be Worth Over $1 Billion

BOEING CO. has won NASA's biggest launch vehicle contract—over $300 million for the *S-IB* stage of the advanced *Saturn* booster.

While the contract is officially valued at over $300 million, informed sources report that its total value will easily approach—and possibly surpass—$1 billion.

The contract will run through 1966. It calls for the development, construction and testing of 24 flight boosters plus several ground test versions. Boeing has named Rocketdyne Division of North American Aviation, Inc., to assist in the ground-firing of the boosters.

Meanwhile, it was also disclosed that:

• While NASA has decided to move ahead with development of the large *Nova* vehicle, there are no funds remaining in the Fiscal '62 budget for the program. Real work on development of the launch vehicle must now await either a supplemental budget request or the Fiscal 1963 budget which will go to Congress in January.

• The Golovin committee was unable to decide whether the U.S. should build a 160-in. or 240-in. solid motor. As a result, it recommended that before production begins, the Air Force should initiate further feasibility studies.

The space agency is giving serious consideration to a proposal that it use a single J-2 engine developing 200,000 lbs. thrust in the *S-IV* stage of the advanced *Saturn* booster. The J-2 engine would replace the six RL-10 engine stage which would develop a total thrust of 90,000 lbs.

The *S-IB* stage of *Saturn* will be powered by a cluster of either four or five F-1 engines, which will develop a thrust of 6 million or 7.5 million lbs. respectively.

The stage will be 33 ft. in diameter and 70 to 80 ft. high, and will weigh five million lbs. at liftoff. It will be the first stage of the advanced *Saturn* launch vehicle which will boost the *Apollo* spacecraft on circumlunar missions and the manned moon landing if the orbital rendezvous technique is used.

Chrysler Corp. was selected to build the *S-I* stage of the *Saturn*, North American Aviation Inc. will build the *Apollo* spacecraft, and McDonnell was awarded the prime contract for the follow-on *Mercury* manned space flight program.

The *S-IB* stage will be built at NASA's Michoud, La., plant, where Boeing expects to employ 5000 people. Four other firms—Aerojet-General, Space Technology Laboratories, Martin Marietta Corp. and General Dynamics/Astronautics—competed for the contract.

zine/nitrogen tetroxide. Each engine will have a thrust of 200 to 300 lbs. and will be capable of increasing the spacecraft's speed by 500 ft.-per-second during the docking operation with the *Agena B*.

• **Pilot control**—The astronauts on board will control the spacecraft during docking with the *Agena B* in orbit. No unmanned rendezvous flights will be made. For the first time, the pilots will also be able to maneuver the spacecraft during re-entry and landing.

• **Recovery** — During the early flights, the spacecraft will land in the water. In the manned orbital and rendezvous flights, it will return to land, probably on the salt flats at Edwards Air Force Base, Calif. Several other areas in the Southwestern U.S. are still being considered. During the orbital flights, there will be a 30 minute window in which re-entry can be made successfully to achieve the land landing. The capsule will fly at a 32 degree angle-of-attack during re-entry and will have a lift-drag ratio of .3.

One large parachute will be used to slow the spacecraft during reentry and it will very likely be fitted with a para-, or Rogallo-wing to enable it to glide in for the landing.

• **Pilot safety**—Each pilot will have an ejection seat which can be used for low-altitude escape from the capsule. The pilots will sit side by side, each facing a door in the spacecraft's side. For an abort, the door will blow off and the ejection seat with its human passenger will be catapulted. A parachute will then open to lower them to the ground.

• **Subsystems** — These will be installed around the perimeter of the spacecraft so that they can be reached from the outside through doors. This will make checkout procedures much simpler.

• **Life support**—This will be very similar to the system used in the current *Mercury* capsule but it will be expanded to provide support for two astronauts for flights lasting at least one week.

With the advent of the new project, NASA's manned space-flight schedule over the next three years shapes up like this:

The first manned three-orbit flight will be attempted next month. Two and possible four similar flights will follow in two-month intervals.

Late next year, one-day orbital flights will be attempted using a modified *Mercury* capsule, in which certain equipment will be moved out of the capsule and placed in the adapter. This will permit expansion of the life support system from four hours to one day or 18 orbits. At least two of these flights are scheduled.

The space agency will then move into the two-man capsule flights.

Several unmanned ballistic flights will be attempted from Cape Canaveral.

Then a series of one day, three day and one week manned orbital flights will be attempted beginning in 1964. Once manned flight in the spacecraft has been proved, NASA will then move into the orbital rendezvous phase of the program late in 1964.

• **Docking operation**—In the rendezvous operation, the *Agena B* will be launched by an *Atlas* booster into a 150-mile nautical orbit. It will then be tracked for approximately one day to determine its precise orbit.

The information will then be fed automatically into computers to determine the exact time that the spacecraft should be launched.

Its *Titan II* booster will send the spacecraft into an elliptical earth orbit which will vary from 100 miles to 150-mile-high altitudes.

Thus, when the spacecraft is at apogee, it will be in the same orbit as the *Agena B*. As soon as possible, the spacecraft's pilot will lock on to the *Agena B*. To do this, the pilot will utilize air-to-air sensors, transponders and electric magnetic sensing devices.

Once he is locked on his target, the closing phase will begin with the firing of the spacecraft's hypergolic engines. These will furnish the necessary propulsion to increase the speed of the spacecraft so that it can dock with the *Agena B*.

Just prior to re-entry, the *Agena B* vehicle will be jettisoned and the spacecraft will land alone.

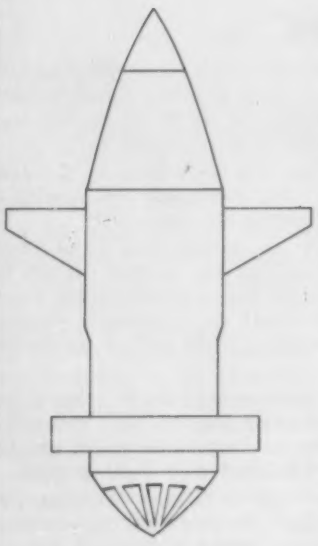
One of the big problems facing McDonnell is the design and development of the equipment needed for the spacecraft and the *Agena B* docking operation. While both NASA and McDonnell have a general idea of what is required, this phase of the program is reported to be still in early R&D.

McDonnell was awarded the *Mercury* capsule contract on Jan. 12, 1959. The firm delivered the first flight version in February, 1960, and had turned over 13 capsules by June 30, 1960.

Total cost of the *Mercury* program is $400 million through FY '62—including the 19 capsules which NASA has ordered. The first manned ballistic flight was made on May 5, 1961; the second in July.

The chimp "Enos" was sent on a two-orbit flight in the capsule late last month. If no more technical troubles develop, the U.S. will orbit an astronaut in the second half of the month. ⌗

Soviets Show Model of Vostok II with Short Wings



RUSSIA has unveiled a model of *Vostok II* showing the manned spacecraft with two stub wings.

The model was included in a film shown at the Russian Embassy in London recently. Soviet officials said *Vostok II* differed from *Vostok I* and the wings were new. They connected them with the maneuvers Maj. Gherman Titov reportedly carried out during the last orbits of his 17½-orbit Aug. 6 flight, when he was in denser regions of the atmosphere.

There has been continued speculation in the west that *Vostok's* were winged and that they were being designed as a military spacecraft. The model, however, is the most concrete evidence to date that this is the case.

Like a mockup of *Vostok I*, the *Vostok II* model had a tail annulus, which was provided with moving shutters or flaps. The craft was liberally equipped with long whip antennae, four at the head, four at the tail and more amidships.

There are reports that Russia is working on orbital rendezvous. The various control surfaces of *Vostok* may be designed for the necessary maneuverability in space. ⌗

UTC Fires 100-in. Segmented Booster

Success comes as DOD prepares to ask for proposals on 120-in. solid; four other major manufacturers in competition

PROPOSAL REQUESTS for the 120-in. solid booster are expected to go out to industry from the Pentagon within the next two weeks—hard on the heels of the successful firing of United Technology Corp.'s 100-in. segmented, conical booster.

United Technology is one of the three firms currently engaged in applied research directed toward the 120-in. motor, which probably will be segmented. The others are Aerojet-General which fired a 500,000-lb.-thrust prototype last summer, and Lockheed Propulsion, which expects to fire a 120-in. motor in the near future. Along with Thiokol, all are competing for the booster contract.

Earliest use of the big solids is likely to be as a cluster around the *Titan II Dyna-Soar* booster—the so-called *Titan III*.

Fiscal '62 funding for large solid boosters runs about $77 million—$50 million for the booster, $15 million for solid upper stages and $12 million for launch facility construction.

• **Nose-down firing**—The UTC motor generated about 500,000 lbs. of thrust during the 80-sec. firing. Designated the P-1-2, the 130,000-lb. motor consisted of two 30-ton center segments and two smaller capping segments. The motor was conical, with a 1.5° taper. This conical approach is UTC's method for large boosters.

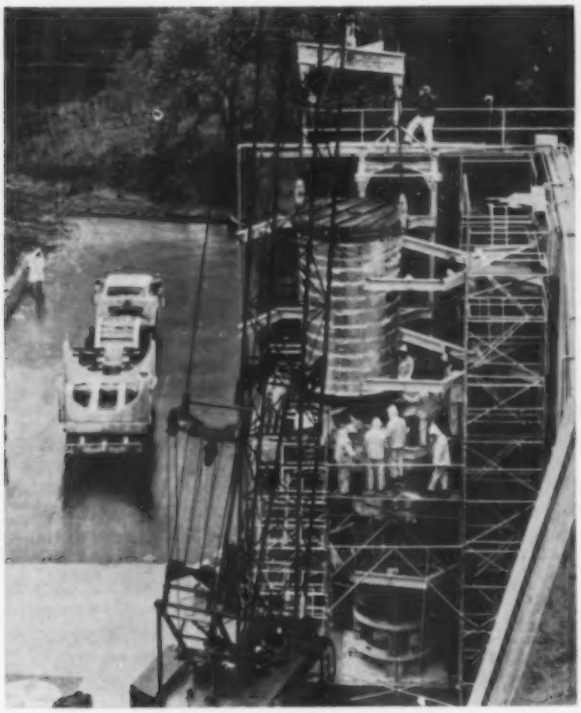
The motor was fired nose-down in a concrete test stand designed to handle engine thrusts up to 2 million lbs. The segments were assembled at the stand under field conditions without the use of tools.

A new nozzle design was used and a liquid injection thrust vector control unit was also checked out in the firing. The 2-ft.-thick propellant charge was ignited by a "small rocket." B. R. Adelman, UTC executive vice president, said the igniter was too big to be considered a squib.

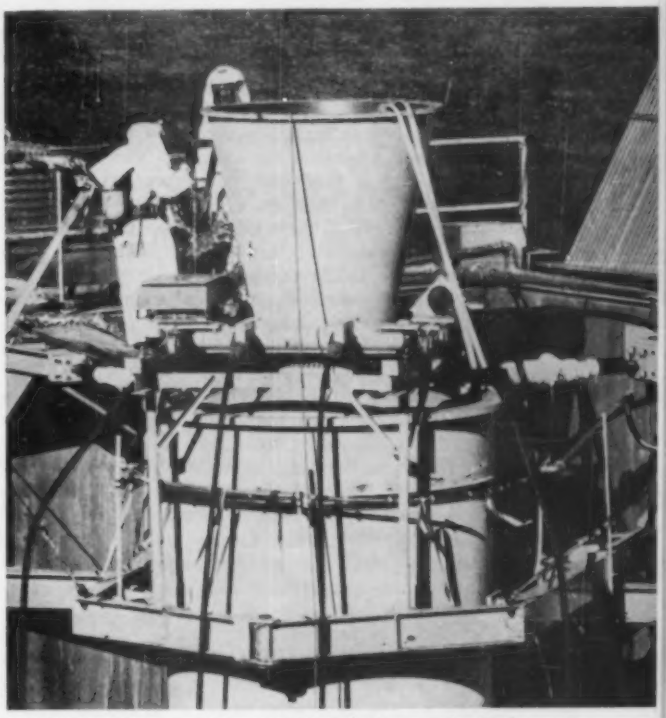
The motor had all the characteristics of a flightweight model, but its mass-fraction was not disclosed. UTC experts consider any propulsion unit with a mass fraction of more than 0.86 as flightweight.

The firing took place Dec. 9 under a recently negotiated contract with the Air Force Space Systems Division. AF officials called the test part of an expanded program to push the state of the art in solids.

UTC expects to test a 120-in. motor next spring. The firm develops prototype boosters with flightweight hardware from the beginning. Adelman says this approach is initially risky, but the gains are considerable as the associated problems are solved. ¤



SECOND MAIN segment is lowered into position with a crane. The sections are joined with a flightweight clevis-type joint—without the use of any tools.



TECHNICIANS wearing protective clothing make final nozzle adjustments prior to firing UTC's 43-ft. solid motor. A liquid injection vector control was included.

Computer Conference Reflects Boom

EJCC told sales were $1 billion in 1961; IBM discloses details of Mercury computation system

by Charles D. LaFond

THE ELECTRONIC data processing industry delivered $1 billion in equipment this year and current annual R&D expenditures in the field are about $150 million.

Conceived only 15 years ago, the industry has enjoyed technological advancements adding up to one of the greatest revolutions of modern times, said Dause L. Bibby, president of Remington Rand Division of Sperry Rand Corp., keynote speaker in Washington last week for the 1961 Eastern Joint Computer Conference.

Bibby reported that over 5000 computers are in operation today, and forecasts indicate that between 10 and 15 thousand will be in use in the U.S. alone in 5 years. By 1970, he predicted, the value of communication equipment to handle data transmission among computers will be equal to the value of the computers themselves.

Examining another aspect of the U.S. computer industry, Bibby asserted that it may turn out to be our most potent weapon for national survival.

Soviet Russia has at least 200,000 more scientists and engineers than the U.S., he noted, and is producing new ones faster than we are. And the situation shows no signs of improvements.

The computer, he declared, can provide a partial answer to our manpower shortage. It can help our engineers to do more work in less time. The extent to which computers enter this equation may well decide our fate, he concluded.

• **EJCC summary**—This year's exhibits, in marked contrast with the 1960 show, returned to emphasizing military, scientific, and space computer systems.

A reduction in the number of purely business/commercial systems and an underlining of complete systems rather than components was the principal change in the first meeting sponsored by the new American Federation of Information Processing Societies.

Founded last May, AFIPS replaces the National Joint Computer Committee and presents a unified society made up of three major electronics organizations: the Institute of Radio Engineers, American Institute of Electrical Engineers, and the Association for Computing Machinery.

Expecting an attendance of over 4000, nearly 90 manufacturers demonstrated their best in on-line equipment. Considering the types of systems shown, this may represent the costliest show yet in equipment dollars/square foot.

The most enormous display was that set up by Remington Rand's Univac division. It had a duplicate of the vast information retrieval center developed for ASTIA, the Armed Services Technical Information Agency. Heart of the complex, which occupied about 13 regular exhibit booth areas, was the new solid-state Univac 80 computer.

Quality of technical papers this year also was unusually high—conference officials said only 29 out of 242 submitted papers were selected for presentation.

• **Mercury computers**—For the first time, IBM's Federal Systems Division presented details of the Project *Mercury* data computation system. Four papers emanating from the division's Washington headquarters described (1) the role of the system digital computers, (2) programing, (3) real-time simulations and (4) the launch monitor subsystem for the project.

The first paper, by S. I. Gass, reviewed the use of digital computers in the system as an integral part of the real-time decision-making complex. These, he said, are employed to process observations made in the launch, orbit, and re-entry phases of each mission and are used to supply a continuous, up-to-date record of the non-environmental status of the craft.

Duplexed IBM-7090's at Goddard Space Flight Center, Greenbelt, Md., receive inputs during launch. Radar inputs from the worldwide *Mercury* tracking net are fed in continually during orbit and re-entry phases.

After processing, outputs from Goddard are returned to the giant display center at the Command Control Center, Cape Canaveral. (Total receipt, processing, and return time is about 1 sec. for a given piece of data, according to Charles L. Bradshaw, deputy director of the computation division, Marshall Space Flight Center.)

Flight-control backup is provided by a simplex IBM 709 complex in Bermuda.

It is essential, Gass said, that both centers be capable of providing in real-time a variety of trajectory data, present position, acquisition messages, impact and other decision-making elements throughout the entire mission.

Principal subsystems feeding the Goddard 7090's include: *Atlas* radio-inertial ground guidance computers for tracking and command control of the launch vehicle; a 7090 impact prediction computer at the Cape, tied in with the Azusa beacon there and radar inputs from Grand Bahama Island, San Salvador Island and the Cape, for real-time trajectory data including position and velocity, every 0.4 second at 1000 bits/sec; down-range radar-facility inputs for range, azimuth, and elevation measurements (via the 7090 impact predictor); telemetry signals via the Cape for capsule operation and condition; and finally, smoothed radar data from the Bermuda station are fed directly to Goddard via teleprinter circuits.

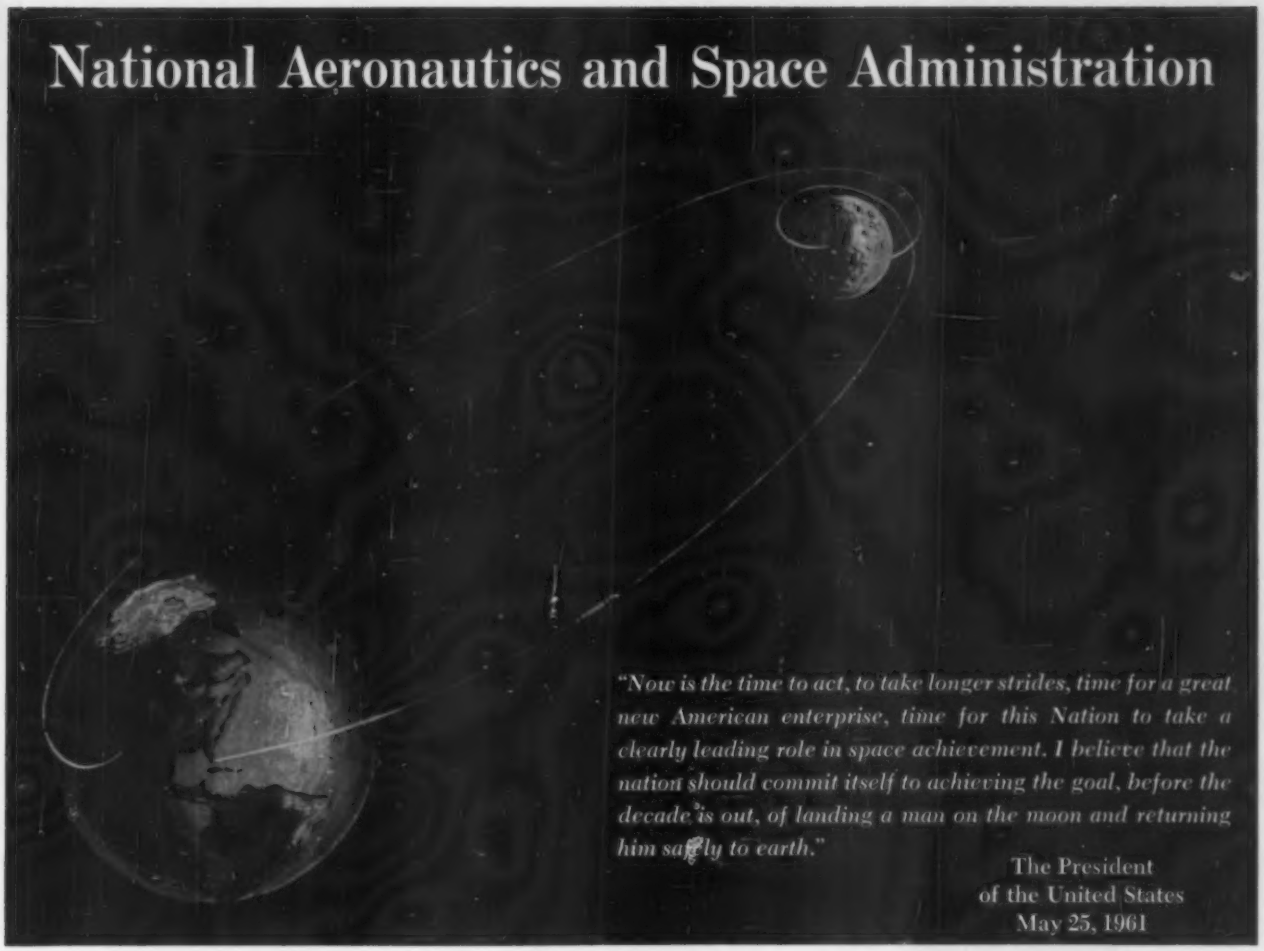
• **System inputs, outputs** — Each paralleled 7090 at Goddard is connected to 12 magnetic tape drives, an on-line printer, punch and card reader, and a data communications channel (DCC, IBM-7281). The DCC permits data transmission to flow directly to and from each system's 32,000-word core memory. Each DCC handles data over 32 subchannels.

Inputs to the communications channel consist of 17 teleprinter circuits, two high-speed inputs, a WWV minute time signal, and a half-second time signal.

Outputs from Goddard are through two high-speed circuits, three teleprinter circuits, and a sense-output console. Since only one 7090 transmits processed data, the console provides switching from one computer to the other.

A description of the programing for the system, including all the modes of operation, routines, system monitoring, and computer switching was presented by M. B. Scott and R. Hoffman. ⌗

National Aeronautics and Space Administration



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The President
of the United States
May 25, 1961

The nation has committed itself to accelerate greatly the development of space science and technology, accepting as a national goal, the achievement of manned lunar landing and return before the end of the decade. This space program will require spending many billions of dollars during the next ten years.

NASA directs and implements the nation's research and development efforts in the exploration of space. The accelerated national space program calls for the greatest single technological effort our country has thus far undertaken. Manned space flight is the most challenging assignment ever given to mankind.

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NASA invites you to address your inquiry to the Personnel Director of any of the following NASA Centers: NASA Manned Spacecraft Center, Houston, Texas; NASA Goddard Space Flight Center, Greenbelt, Maryland; NASA Marshall Space Flight Center, Huntsville, Alabama; NASA Ames Research Center, Mountain View, California; NASA Flight Research Center, Edwards, California; NASA Langley Research Center, Hampton, Virginia; NASA Wallops Station, Wallops Island, Virginia; NASA Lewis Research Center, Cleveland, Ohio; NASA Headquarters, Washington 25, D. C.

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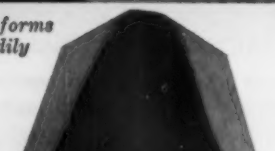

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Technical Countdown

ELECTRONICS

AC Titan Guidance Passes Quarter-Year Mark

The guidance package for the Air Force's *Titan II* ICBM recently logged a quarter of a year of continuous operation. Built by AC Spark Plug, the inertial package passed the 2000-hour mark as part of an overall systems test program being conducted in AC labs.

Centaur Slippage Benefits Some

The propulsion problems which forced a delay in the *Centaur* program have had at least one beneficial side effect. The relaxation of the previously tight schedule has enabled Minneapolis-Honeywell to incorporate design improvements of the pulse-balance electronics into the inertial guidance system.

Radiation Hazards Overestimated

Area of the Fylingdales BMEWS station in England will be reduced by 1500 acres due to the downgrading of the expected microwave radiation hazard. This was decided after joint U.S.-U.K. studies on the operational aspects and power distribution of high-power radar systems. The site will now occupy 900 acres.

Pneumatic Guidance Computers Next

Martin Marietta's Orlando division is pushing development of pneumatic computers for missile guidance. Division engineers believe they can produce a miniature package several orders of magnitude smaller than existing electronic types at half the cost. And tests so far indicate pneumatic systems will operate satisfactorily in temperatures up to 2000°F. Kearfott Division of GPI and the Marquardt Corp. are contributing to the development. Both analog and digital prototypes will be tested soon, Martin says.

ADVANCED MATERIALS

CBS Lubrication Claims Annoy NASA

NASA scientists following the development of dry-film lubrication techniques are reportedly annoyed at some of the recent claims made by CBS Laboratories in Stamford, Conn. (M/R, Dec. 11, p. 28). Space agency officials feel that considerably more testing under a wide range of conditions—particularly high temperature and heavy radiation environments—is needed before any conclusions can be reached as to the overall effectiveness of the new CBS process.

Thiokol May Build Big Booster Cases

Engineering teams from Thiokol's Wasatch Division have been eyeing a former Naval Ordnance plant at Pocatello, Idaho, for use in performing production operations on large metal and plastic components. The firm's proposed use falls into four categories—case preparation, warehouse operation, fabrication and rehabilitation of rocket component tooling, and fabrication of large rocket cases. The economy of the operation has yet to be established.

PROPULSION

Marquardt Tests Cold-Wall Rocket Motor

A 25-lb. high-efficiency rocket motor with cold outer walls, designed for satellite and space vehicle reaction control, has been successfully tested by Marquardt Corp. The unit was pulsed repeatedly, then subjected to 20-second, 60-second and 10-minute steady-state full-thrust runs. Outer-wall temperature leveled off below 200°F after one minute. Shut-down heat soak-back ran the temperature up to 240°F. The firm says the motor is capable of relatively unlimited operational life in both running modes.

Micromotors Tested at Aerojet

Another satellite control motor using hypodermic needles for injectors is being fired at Aerojet's Azusa plant. The half-ounce unit generates between 0.1 and 0.01 pound thrust and is designed for day-long operation. The engine has been operated continuously for 30 minutes. Since the thrust is so low, the propellant lines can hold it to the satellite proper.

Price Cut for Thermoelectric Materials

New production techniques developed by Alloys Unlimited Chemicals, Inc., will cut quantity prices of polycrystalline bismuth telluride and lead telluride by two-thirds, the company says. Widely used in thermoelectric devices, both are available in P- and N- types lead telluride in ½-in.-square ingots in 6-10-in. lengths, bismuth telluride ingots in 6-in. lengths and in diameters of 4, 7, and 14 mm. AUI says the new prices will be under $50 a pound.

ASTRONAUTICS

Effects of Rocket Exhaust Under Study

Possible long-range modification of the upper atmosphere by exhaust gases and particulate matter from large rocket engines is under study by the Geophysics Corporation of America. The ARPA-sponsored investigation is designed to anticipate the atmospheric effects which may result from launchings of *Saturn* and *Nova* type vehicles.

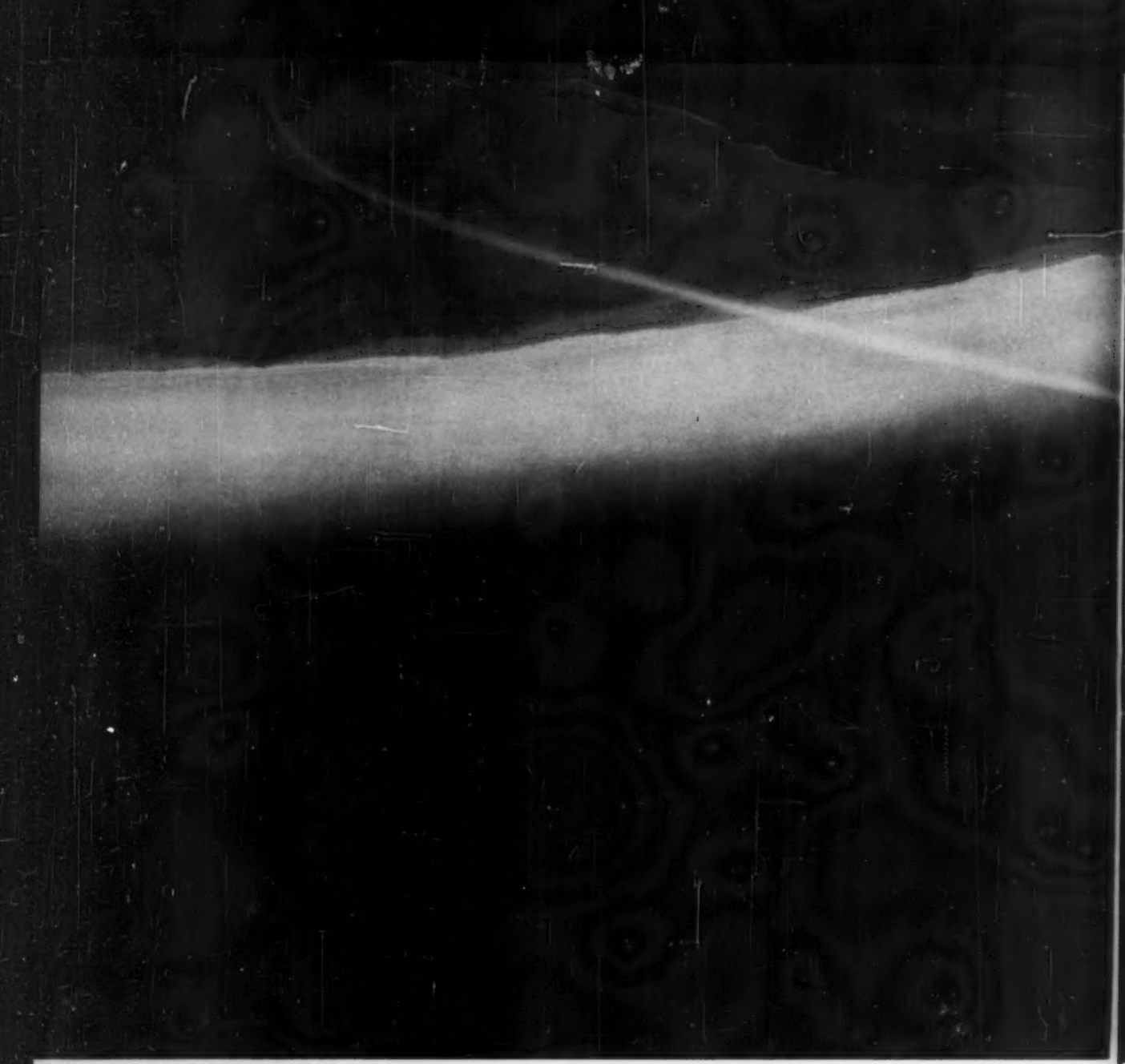
SUPPORT EQUIPMENT

ComSats To Speak German

A ground station capable of handling up to 600 phone calls simultaneously will be built by the West German Post Office and is expected to be operational in late 1963 or early 1964. Construction of the ComSat station will get under way next spring near Munich. It will consist of four automatic tracking antennas, designed for operation with *Telestar* and *Relay* type satellites.

Arnold Tests High-Altitude Chamber

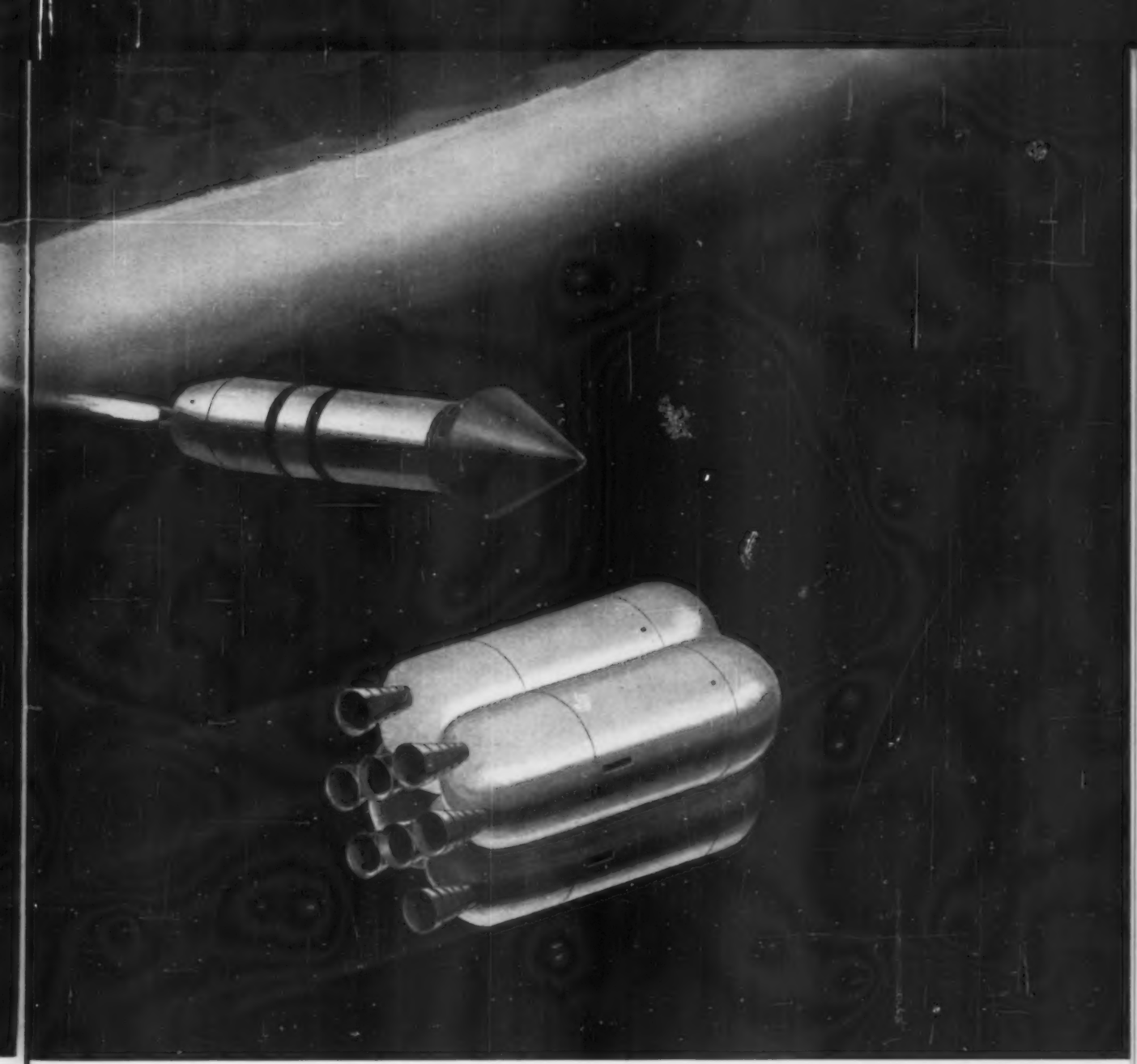
Preliminary shakedown tests of the new high-altitude rocket-engine test chamber at the Air Force's Arnold Engineering Center have been highly successful, Center officials report. The 19-ft.-diameter test cell attained a simulated altitude of 365,000 ft.—corresponding to a pressure of less than 3.2×10^{-5}mm of Hg. AF officials describe the cell as the largest U.S. vacuum chamber available for testing chemical rockets and full-scale satellites and space vehicles under a simulated space environment.



Raytheon brings proven guidance and

Three techniques are currently available to meet the challenge of Space Rendezvous Guidance: radar, infra-red and optics. Of these techniques, radar has been used for homing guidance systems to the greatest degree. Studies by Raytheon, whose radar experience spans three decades, have indicated that continuous wave radar possesses these desirable characteristics:

- No minimum or 'blind' ranges
- Greater range for a given weight
- Simple FM Techniques for ranging
- Direct and accurate velocity readings
- Ease of acquisition
- Greater simplicity and reliability



sensor capability to space rendezvous

The experience gained from the inertial guidance system for the advanced Polaris, coupled with the proven success of the Hawk and Sparrow C W homing systems give Raytheon the most extensive proven capability applicable to the space rendezvous guidance problem.

In addition, Raytheon, one of the world's largest scientific-industrial organizations, has proven its ability to manage every phase of a complex system — from early study and design through development, production and field support of operational systems and equipment.

Missile and Space Division, Bedford, Massachusetts

RAYTHEON COMPANY

MISSILE AND SPACE DIVISION

RAYTHEON

LOOKING SOUTH from Complex 37, this drawing also shows Complex 34—the site of recent Saturn launch.

space support

Complex 37 Will Dwarf Predecessors

Construction under way on launch site to be completed in time for '63 Saturn shots

by Michael Getler

A HUGE NEW rocket launch site, double the size of any facility now in operation, is under construction at Cape Canaveral.

Officially called Vertical Launch Complex 37, the 120-acre tract at the north end of the Cape will be the launching scene for two-stage *Saturn* boosters by mid-1963.

Three major construction awards for about $20 million have already been let for work on the first of two pads and some support systems. Another $11 million has been approved by NASA for completion of the second pad. Award of this contract is expected in March.

Winner of the initial construction contract for Pad B was Blount Bros. Construction Co. of Montgomery, Ala. Blount has also been chosen to supply several of the supporting systems for both launch areas.

Pad B, now about 5% completed, will be ready by November, 1962, according to the Army Corps of Engineers, who are supervising design and construction for NASA. Construction on Pad A, which will be a duplicate of the first site, should be completed by January, 1963.

Two Florida architectural and engineering firms were called in for assistance in designing the complex. Maurice H. Connell & Associates, Inc., of Miami, worked on the superstructure; Reynolds, Smith and Hills, of Jacksonville, on subsurface facilities.

Pads A and B at the complex will have individual automatic ground stations, launch pedestals, and umbilical towers. Structures common to both sites include a launch control center, or blockhouse; operations support building; propellant storage and transfer facilities; and a mobile, self-propelled service gantry riding on 1200 ft. of steel rails between the two launch stands. The massive 300-ft.-high gantry, extendable to 330 ft., is probably the largest movable structure in the world.

Here is a breakdown on available statistics for key elements at the launch complex:

• **AGC Buildings**—Two of these 50-ft.-wide by 122-ft.-long structures will be built directly beneath a portion of each umbilical tower. The buildings, which are unoccupied during launching, are multi-tiered, with three above-ground stories in the area under the umbilical tower, two stories exposed immediately adjacent to the tower, and a basement level running the length of the building. An ac/dc generator room is included within the AGC building, in addition to various instrumentation and checkout equipments for the booster vehicle. Electric power and high-pressure gas distribution equipment are also located here.

• **Umbilical towers**—Both are steel structures 268 ft. high, each on a 32-ft.-square base. These towers will be extendible to 320 ft. The maze of power, propellant, communication, and pre-launch check-out lines which wind through the tower to the missile created some problems in dynamic stability of the structure under heavy wind loadings. The extensive amount of con-

duits and piping created a tower surface nearly equivalent to a solid structure. To insure maximum stability, main tower columns and diagonals will be fabricated with 50,000-psi-yield steel, and special high-strength bolted joints will be used to damp severe oscillations.

• **Launch pedestals**—Both launch platforms at Complex 37 will be 47-ft.-sq. by 7 ft. deep, with a 12-sided cutout —32 ft. in diameter—in the center for vehicle engine exhaust. Triangular platforms will be mounted on top of the pedestal to enlarge the work area to a 55-ft.-sq. base.

The welded steel pedestals will be of box-beam type construction fabricated from 1, 1½, and 2-in. plates. An elevator and two staircases are included to provide ground access.

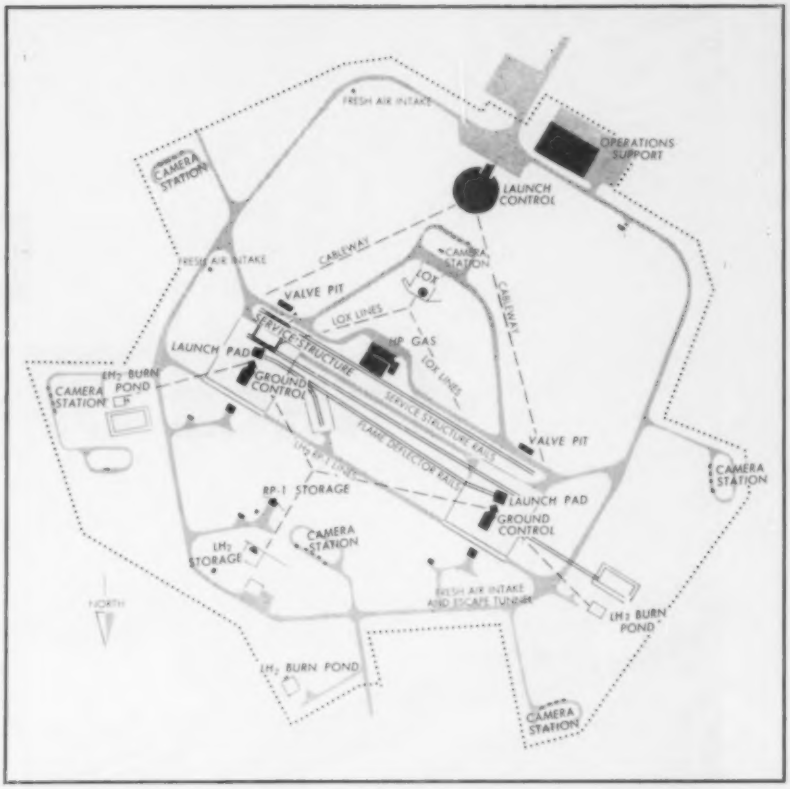
Initial fabrication, assembly, and checkout of the launch pedestal will be undertaken at the Todd Shipyard Corp. facilities in Houston, Texas. Todd and Blount Bros. are both invoived in this phase of construction. Upon completion of the tests, the unit will be disassembled and shipped in quadrants to the Cape. Pedestal design was accomplished by a section of the Launch Operations Directorate at the Marshall Space Flight Center.

• **Blockhouse**—The launch control center interior measures 110 ft. in diameter and 37 ft. high. The blast-resistant dome is 12½ ft. thick, only slightly thicker than those employed in much smaller blockhouses. Just over 5 ft. of the dome thickness is reinforced concrete. The remainder is an earth fill. A total of 3290 cu. yds. of concrete and 400 tons of steel will go into dome construction. Main firing functions, tracking, observation, and test supervision will come from within this structure.

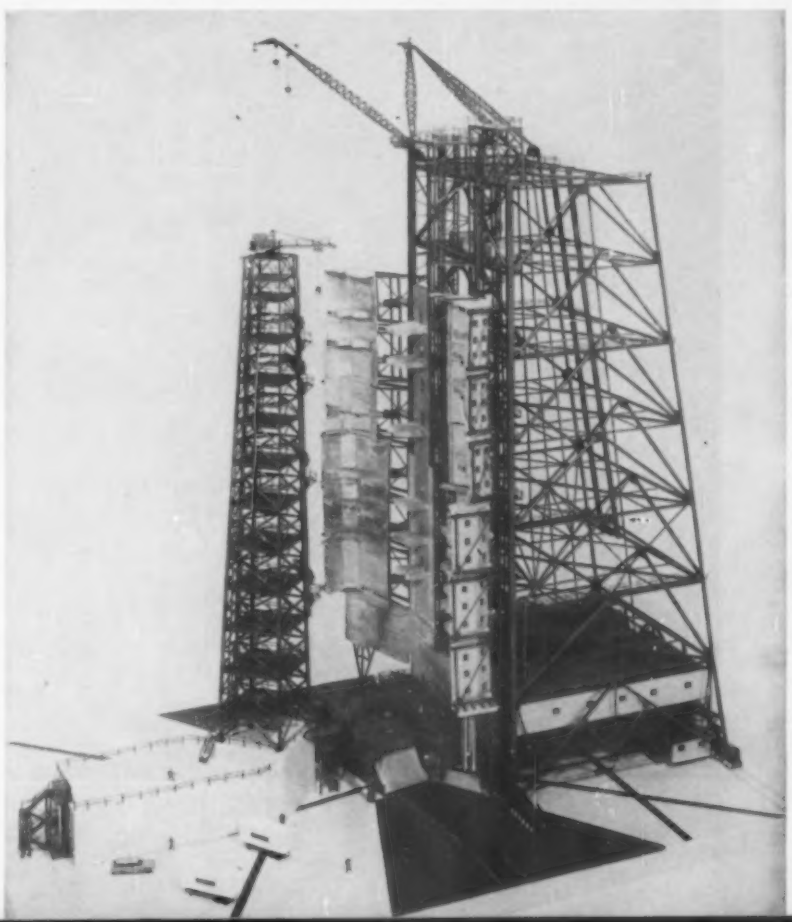
• **Storage and transfer**—Three separate propellant storage and transfer systems have so far been contracted for. The liquid ovygen system includes two tanks, one a 125,000-gal. storage unit and the other a 28,000-gal. vacuum-jacketed replenishing tank. A 43,500-gal. cylindrical steel tank will be installed to store the RP-1 kerosene fuel. Included in the high-pressure gas facility will be a storage battery with a 4000-cu. ft. water volume, a 35,000-gal. liquid nitrogen storage tank, a nitrogen vaporizer, liquid nitrogen pumps, helium compressors, and gas driers.

• **Service gantry**—Completely dominating the scene at Complex 37 will be the 7-million-lb. (basic weight) service gantry. Situated on a 120-ft.-square base, the gantry—including a derrick mast riding above the extended superstructure—will rise 375 ft. above the Cape. The derrick and 90-ft. boom

(Continued on page 47)



ABOVE: *Layout of new launch area shows location of major structures and support systems.* **BELOW:** *Model of huge service gantry (right), umbilical tower (left) and launch pedestal (center). AGC building is shown at the base of the umbilical tower.*



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Signals Intensify with Sunspots

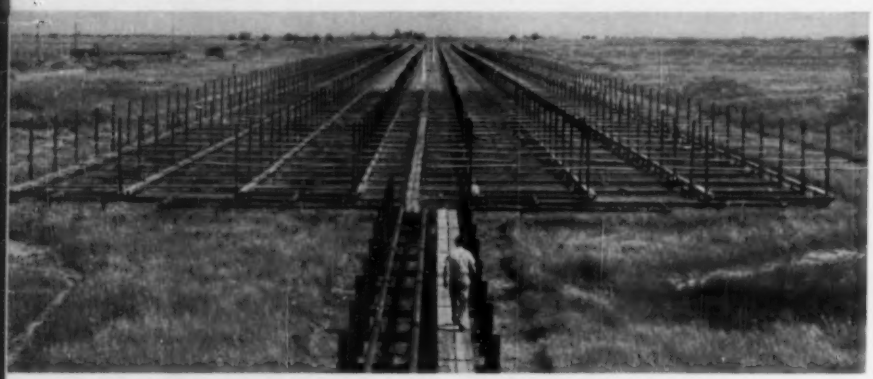
VARIATIONS in solar activity appear to have a corresponding effect upon the reflectivity of radio waves transmitted to the sun from earth.

Increased radar echo intensities during periods of heavy solar radiation were recorded by a group of Lincoln Laboratory scientists working under a tri-service program to correlate solar phenomena with variations in radar reflectivity. The study may also lead to an improved early warning system against sunspot activity.

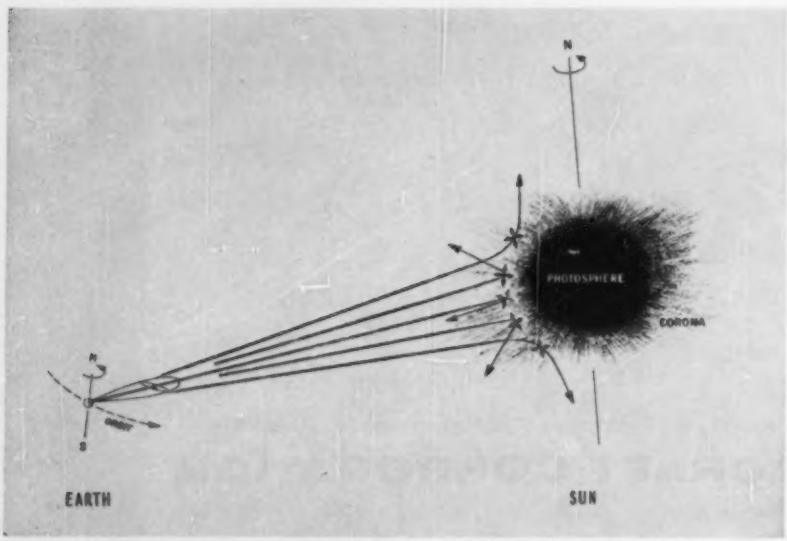
In the past, the most serious consequence of the solar action has been the disruption of earth communications. However, with the advent of manned spacecraft the hazards of violent solar storms become more personal. Clouds of high-energy particles could be directly fatal or could cause disablement of all electronic systems aboard the vehicle.

Even for unmanned deep-space probes, the high cost of space hardware warrants an improved sunspot prediction capability.

The findings of the four scientists, reported in the December issue of the *Journal of Geophysical Research*, represent results of the first in a series of regular radar measurements of the sun's corona made over an extended period of time.



DIPOLE ANTENNA ARRAY at El Campo, Tex., for Lincoln Laboratory's vhf space-radar system, is made up of 1024 dipoles driven by 500,000-watt transmitter.



DRAWING ILLUSTRATES irregular reflection of radar signals from solar corona, nearly 93,000,000 miles from earth. Signals' round trip takes 16 minutes.

Using a 500-kw, vhf transmitter, originally developed for ionospheric-scatter communications research, the Lincoln Lab team established radar contact with the sun on 32 days over an 11-week period from April 19 to July 7.

Sunspot activity during this period, the scientists said, was relatively low. Near the end of the test period, solar activity increased—with a corresponding increase in echo signal intensity.

• **High power, low antenna cost**—Field site of the space radar system used in the tests is near El Campo, Tex. The half-megawatt transmitter is believed the most powerful vhf radar in the world, a lab spokesman said.

A relatively economical array of 1024 individual dipole antennas is used for both transmitting and receiving. The array consists of eight rows of 128 antennas each. Each row is roughly 1700 ft. long; separation between rows is 15 ft. The antenna system produces a fan-shaped beam 15° wide (east-west direction) and 0.75° thick. Operating frequency is nominally 38.25 mc.

Signals are transmitted continuously for 16 minutes—about the time required for a signal to make the complete trip to and from the sun. To assist signal discrimination against cosmic noise and solar radiations, frequency stepping is employed in increments of 8 kc at 8-sec. intervals. An irregular but carefully controlled switching pattern is employed to assist in signal identification.

Frequency stepping is used instead of conventional radar pulsing, the scientists said, to permit continuous transmission and, thus, obtain the highest possible average power.

• **Tailored beam pattern**—Antenna aiming is accomplished electrically by adjustments on the connections to each dipole.

The photosphere (or visible solar disk) subtends an angle of about 0.5°, when viewed from the earth. During the 16-minute transmitting period, the sun's path covers half of the 15° beam width. Thus, the sun is visible to the radar for the full operating time without the need for reorienting the antenna array.

Beam thickness is just enough to permit observations of the solar disk and the surrounding corona. ⌘

'Digilock' System Passes First Flight Test

Low-power telemetry package by Space-General closely approaches theoretical maximum communication efficiency

by Arthur H. Collins

AIR FORCE Blue Scout Jr. blasts off from Pt. Arguello on Dec. 4 in successful first flight test of Space-General Corp.'s Digilock low-power telemetry system.

THE AIR FORCE has successfully flight-tested a low-power telemetry system intended to transmit data over long distances in space.

Employing only 0.25-watt transmitted power, the first Digilock system developed for the Air Force Systems Command's Special Weapons Center by Space-General Corp. was flown Dec. 4. The telemetry package was aboard a *Blue Scout Jr.* payload lofted to an altitude of about 27,000 miles from Point Arguello, Calif.

The payload, designed to measure solar-originating low-energy protons, originally was to have carried a second telemetry system—an FM/FM subsystem for vehicle performance data—but this was eliminated to allow the addition of more scientific instrumentation.

The Digilock used in a second subsystem employed a specially encoded PCM technique.

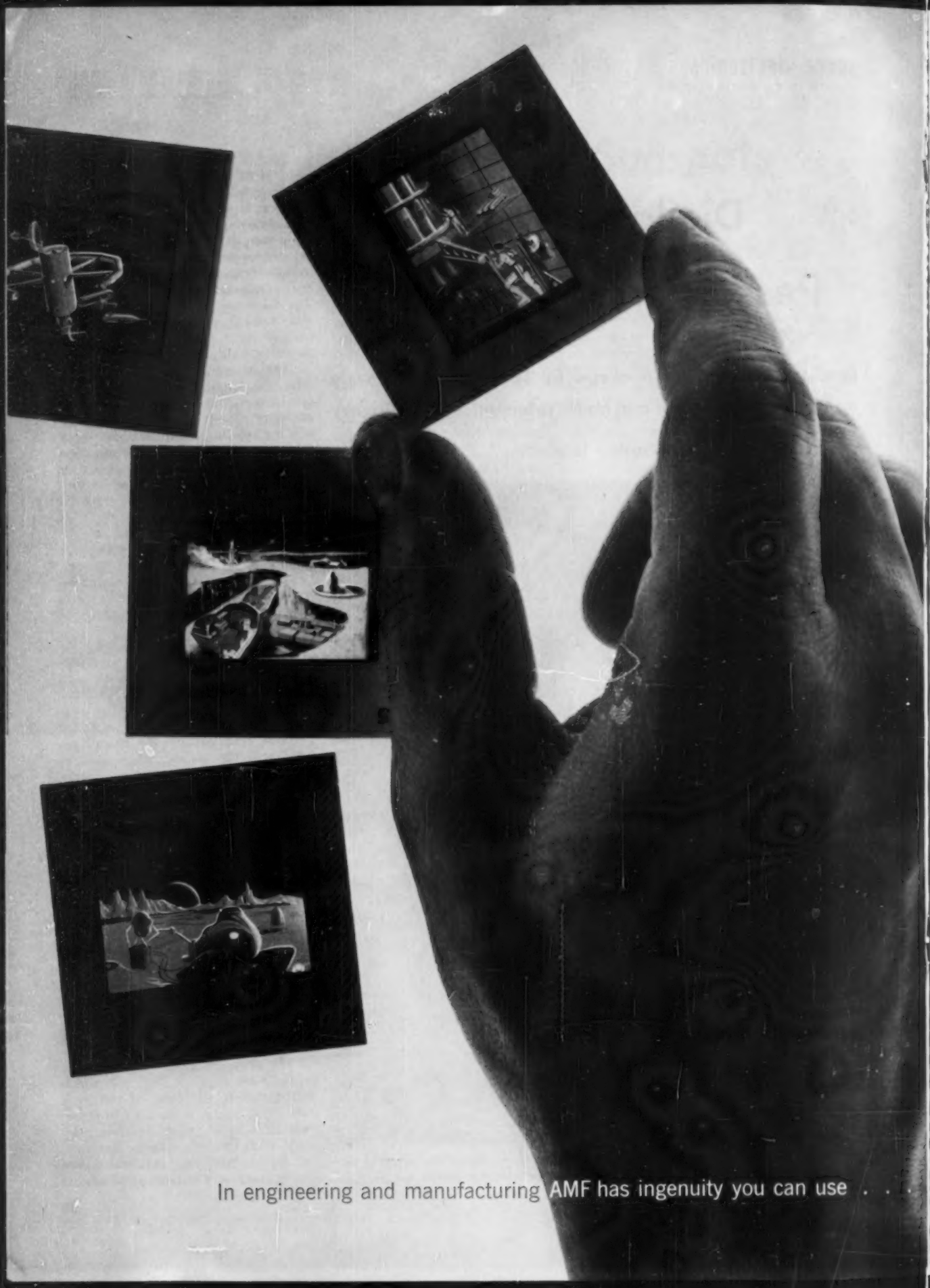
• **Orthogonal** — Dominant in the Space-General system are the Digilock codes—derived from Reed-Muller orthogonal codes. These consist of a number of different binary sequences, with each sequence representing digital input data of a different value.

As used in the AFSWC payload, 32 values of Digilock input data were represented by 32 code-sequences with each sequence containing 16 bits. Because the 32 values of input data constitutes 5 bits of information, a 16-bit Digilock code contains 11 bits of redundancy. The redundancy is used in such a way as to make the codes orthogonal.

The combined ground-based receiver and decoding unit contains matched filters for each of the codes. Due to the orthogonality of the codes, the matched filter corresponding to the transmitted code will, in the absence of noise, deliver an output—while the outputs of all the other matcher filters are zero.

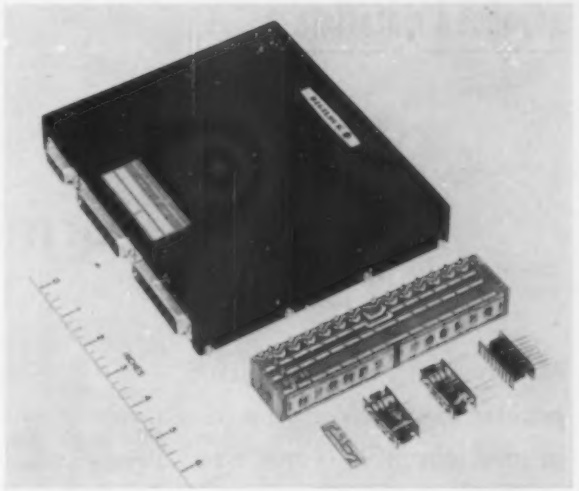
A solid-state commutator in the missile-borne Digilock unit selects the scientific data from one of 20 experiments. A 5-bit binary word is selected in accordance with initiation pulses obtained from the Digilock code generator. The selected word is fed into the data input of the code generator.

The code generator output consists of a 16-bit Digilock sequence which corresponds to the value of the input data. The output is used to bi-phase-modulate the telemetry transmitter by $\pm 60°$. Transmitter output, therefore, can be resolved into an unmodulated carrier plus a constant amplitude rf


In engineering and manufacturing AMF has ingenuity you can use

signal that either leads or lags the unmodulated carrier by 90°, depending upon the instantaneous value of the code-generator output.

A phase-locked receiver at the ground-based receiving station locks to the unmodulated carrier component of the Digilock transmission. The Digilock sequences appear as binary voltages at the output of the receiver phase detector, since loop bandwidth of the phase-locked receiver is too narrow to follow the modulated component of the transmission.



SOLID-STATE COMMUTATOR in missile-borne Digilock selects scientific data from one of 20 experiments.

These voltages are recorded in analog form on one channel of a tape recorder. On a second channel, a time-of-day signal from ground equipment is recorded. A clock signal is recorded on a third channel at a frequency which is an integral multiple of the Digilock bit-rate, and is ultimately used to trigger the analog-to-digital converter in the data reduction system.

• **Playing back** — In the AFSWC system, the recorder tape is shipped to a data reduction center in Albuquerque, N.M., and played back with the receiver video-signal being "integrated and dumped" in accordance with the clock signal from the tape's second channel. The output of the I-and-D circuit is sampled by an analog-to-digital converter just before the dumping and again in accordance with the recorded clock signal. Thus the analog-to-digital converter yields 14 consecutive digital samples for each Digilock bit received.

An IBM data processing computer is used to determine bit-sync from the received data by effectively time-shifting the data through a decoding matrix and noting when the decoder output is maximized. The computer cannot determine the initiation time of a Digilock bit with an accuracy much better than the intersample time. Therefore, it is desirable to have a fairly large number of samples per Digilock bit. The rate of 14 samples per Digilock appears satisfactory, says Space-General.

Digitized samples of the received signal are then recorded on tape in IBM format together with the time-of-day signal. IBM data processing is accomplished by two separate tape run-throughs. The first run determines bit and word-sync for the received data; the second takes advantage of this information to decode the Digilock sequences and determine the transmitted scientific data.

• **Surplus weight**—The entire Digilock encoder is made up of transistorized sub-miniature modules connected and potted in epoxy to form a stick package. Eight sticks were used in the AFSWC package, with the whole unit packaged in a metal case to meet AFSWC requirements.

Space-General, however, believes a much lighter case could be used for most applications. The present package weighs 4.7 lbs., including the 100-wire input cable harness, and has a volume of only 70 cu. in. The Digilock encoder, developers say, requires 112 ma from an unregulated 7.5 v dc source, and 47 ma from an unregulated-6 v dc source. Power consumption is 1.12 watts.

The overall telemetry system for the AFSWC package was designed to meet the specific requirements that vehicle performance data be made available to ground stations with a minimum of processing delay. In contrast, scientific data handled by the Digilock system were not required to be processed with any special rapidity.

The Digilock system has a communication efficiency closely approaching the maximum achievable value predicted by information theory (Shannon theoretical limit).

System versatility enables any number of analog and/or digital inputs to be used, and a wide range of data rates are available. Since the size of the transmitter selected is the only range limitation, the system is particularly suitable for deep-space probe vehicles, orbiting satellites and extended-range ballistic weapons. ⌘

He has a hand in planning for the men in the moon

He's one of a staff of AMF engineers who are solving space environment problems on a here-and-now basis.

He has plans for an orbital launch facility (picture, top left) to help them get there in the first place. Inside, in a shirt-sleeve environment (top, right), a space vehicle can be prepared for launch to the moon itself. On the moon (center), connected structures above and below the surface are required for the Advanced Habitation Engineering needed to support a permanent lunar base. Lunar traverser (bottom) is used to move men and materials and assist in construction of a permanent base.

Already, AMF has designs and concepts which make those pictured obsolete. As new knowledge becomes available, AMF quickly incorporates it into simpler, more reliable, more easily fabricated mechanisms.

AMF has completed and is now carrying on studies and feasibility investigations covering a wide range of space environment problems in conjunction with space vehicle manufacturers and for several government departments. Space environment, itself, is just one of a virtually complete spectrum of AMF defense capabilities.

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'Ardeforming' of Big Solid Cases

Maine firm uses cryogenic process to stretch-form a 30-in.-dia. chamber—any size, shape seen feasible

by John F. Judge

THE SUCCESSFUL cryogenic stretch-forming of a 30-in.-diameter chamber by engineers at Arde-Portland, Inc., is the first step towards proving the application of the method to large solid-rocket booster cases.

The experimental chamber was stretched at 1500 psig with an increase in diameter of 11.7%. Nominal ultimate strength is 245,000 psi and yield is 225,000 psi.

The cryogenic metalworking process, Ardeform, takes advantage of the property of austenitic materials which can be cryogenically worked to a material of high strength and good ductility.

The process (M/R, Aug. 28, p. 32) takes place in a bath of liquid nitrogen at —320°F and transforms the austenite to ferrite to produce the improved material. Since all welds are worked simultaneously with the base metal, weld strength is increased to that of the base metal.

Ardeforming eliminates the need for heat-treating, together with the necessity for expensive straightening and rounding-up of the vessel after quench.

In the 30-in.-diameter chamber series, all four have roll and weld center sections; two use welded composite heads and two employ spun domes. The current test chamber is AISI Type 301 stainless steel.

• **Correlations good** — Arde-Portland burst one vessel (at —320°F) which stretched 22% before failure. It was not a 30-in. chamber. The true stress at failure of this vessel, based on wall thickness at failure was 385,000 psi. All welds were butt-welds and no beefed-up joints were involved. These test chamber results coincided very closely with the theoretical strain limits predicted from uniaxial tensile coupon data.

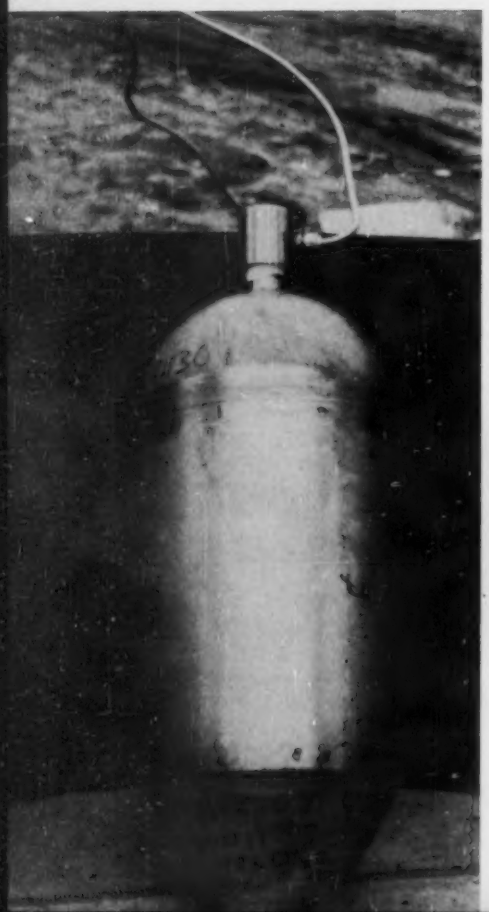
No chamber cryogenically stretched 13% has yet failed ambient temperature hydrotest. In addition, every chamber tested to failure tears in a characteristic way. There is no shattering. The edges of the ear run along a 45° cleavage plane in every case. The chambers remain in one piece, demonstrating their ductility.

Actually, all the conditions of a standard hydrotest are present in the stretch-forming operation. The main difference is the temperature.

Ardeforming permits extremely close volume control; exact uniformity is maintained from chamber to chamber. A-P engineers can give a customer any volume desired — independent of shape.

The firm does not have forming pits large enough to handle the big solid boosters currently being investigated by the propulsion industry. However, Arde-Portland engineers see no technical barrier to applying cryogenic forming methods to vessels of any size.

Transportation is no great problem —the forming facility at South Portland, Me., is right on the ocean. The firm is giving some thought to using nearby abandoned stone quarries for large cases.



LEFT: *The roll and welded truncated closure shown here before cryogenic forming illustrates the relative simplicity of the initial fabrication process involved in Ardeforming.*

ABOVE: *After cryogenic work-out, the closure is expanded to a smoothly curved structure, eliminating the line-construction and strengthening the welds. Weld strength matches that of base metal.*

s in Offing

ALL ARDEFORMED STRUCTURES burst with this characteristic result—a long tear without shattering and a 45° taper on the failure edges.

Analyses have shown no hazard problems in the process. A blast mat, originally placed over the present forming pits has been found to be unnecessary.

Some of the country's largest machine and handling equipment is located next door to Arde-Portland. Although these are not a part of the firm, spokesmen say arrangements can easily be made.

• **Expanded effort**—Other shapes are under active investigation. Spheres have been stretch-formed without dies, with close dimensional tolerances maintained. Other chambers have been stretched to provide data on the forming of a large-diameter boss in a spherical end closure.

A study of the stretching of elliptical and other non-spherical end closures is under way. Since heads and cylinders are geometrically different, different stretch rates are encountered. Investigations already indicate that materials of different ductility can be used to expand the junction of the cylinder and the heads to a vessel of perfect geometrical configuration.

Arde-Portland is also involved in basic metallurgical work on the effect of composition of austenitic stainless steel on the ambient temperature strength attained through cryogenic stretching. Although sufficient data has not yet been collected, Arde experts say an optimum stability level appears to exist. Stability is a measure of the tendency of the austenite to transform.

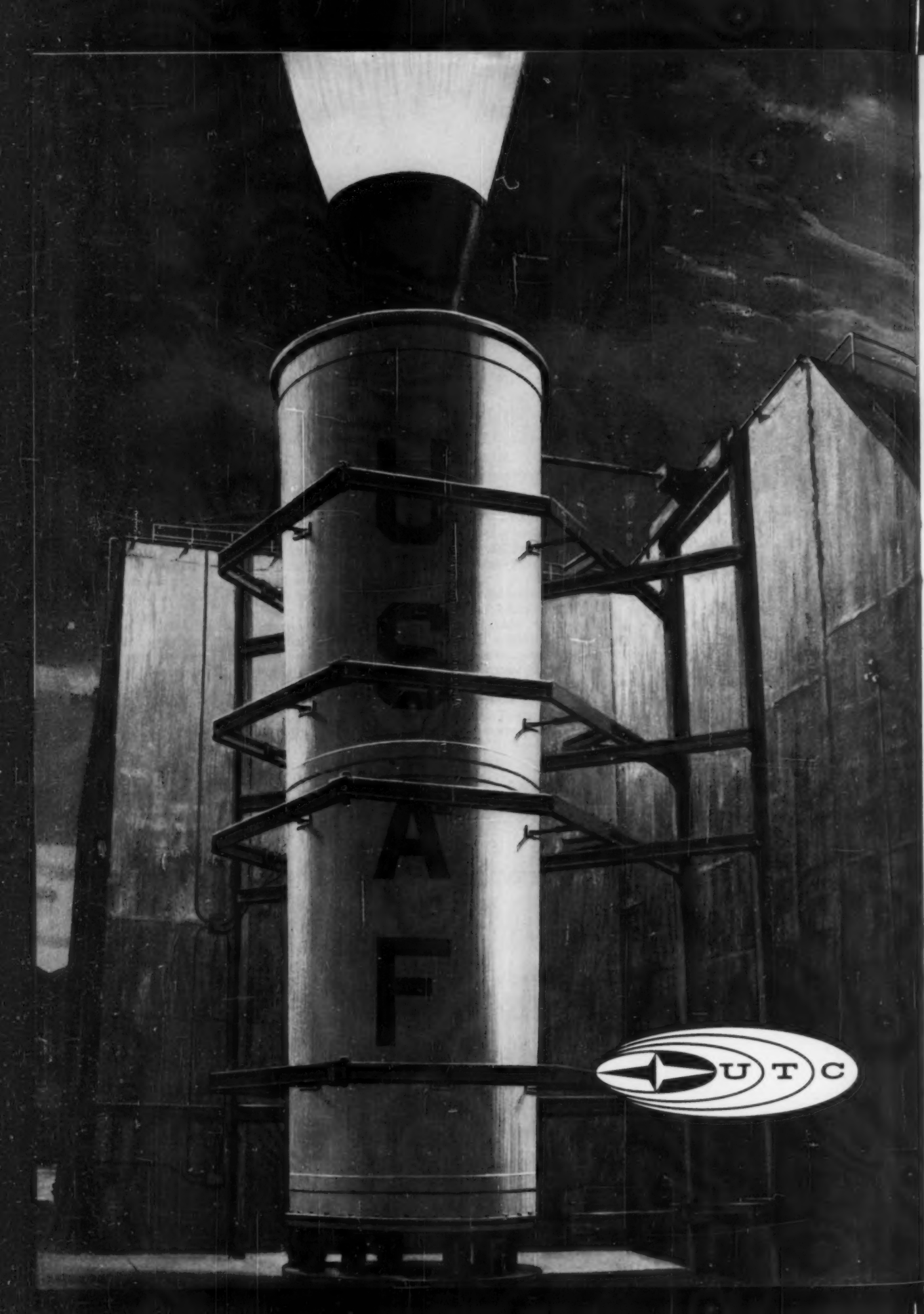
Unstable materials apparently do not retain sufficient austenite at —320° F to allow desirable strain-induced transformations. Too-stable materials do not adequately respond to the cryogenic strain.

Arde has performed innumerable cost analyses on the process. The firm says its process has an economic edge on conventional case fabrication methods. In the big-booster area, a 14-ft.-diameter case could be handled in nine manufacturing steps, as against the 16 or more required by conventional methods.

The main initial cost would be in constructing the facility for larger boosters. Segmented cases can be handled, but the unit must be a closed cylinder for the forming operation. Two extra cutting operations must be made to remove the closures. Arde-Portland experts say this would still be cheaper than a comparable segment fabricated conventionally. ⌘

PREFORM FOR 30-IN. CHAMBER is conventionally fabricated from Type 301 stainless steel without reinforced weld areas. Center cylinder is roll-welded.

AFTER ARDEFORMING OPERATION, chamber was ultimately stretched to 11.7% increase in diameter. Chamber illustrated was interrupted after 1400 psig stretching.


UTC

9 December 1961

A prototype of a huge booster-size, segmented, solid propellant rocket motor was successfully test fired by the U.S. Air Force. The test was conducted for the Air Force by United Technology Corporation at the firm's Development Center near Morgan Hill, California. The giant rocket motor, which was designed and built by UTC, produced nearly a half million pounds of thrust.

United Technology Corporation

P. O. Box 358, Sunnyvale, California

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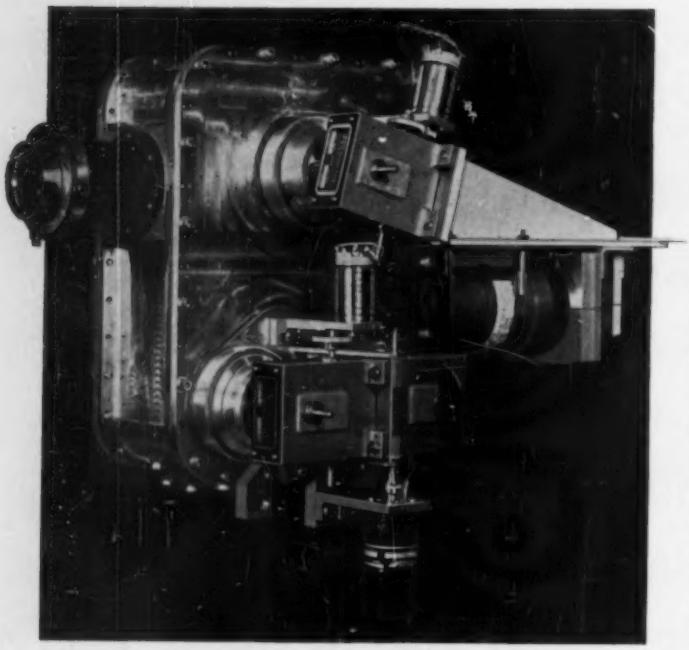
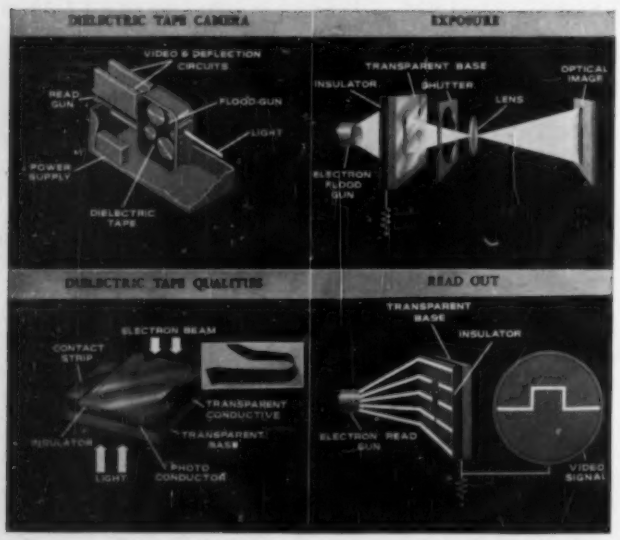
PHOTO-DIELECTRIC TAPE CAMERA SYSTEM

. . . a major advance in space image-sensing





The development of photo-dielectric tape permits the design of a totally new image-sensing system for utilization in satellites and space vehicles. A prototype camera for use with this tape has already been operated and tested. This system, one of the first developed primarily for use in space, offers a number of advantages over existing photographic and television techniques.

Operating on the principle of storing an optical image by converting it to an electronic charge pattern, the photo-dielectric system has inherently high resolution since the picture charge pattern is read out directly as a video signal by an electron beam. Moreover, it offers real promise of providing response in various parts of the radiation spectrum in addition to the visible including infrared and ultraviolet with sensitivity better than standard photographic techniques.

Readout is accomplished by use of a finely focused electron beam which scans the charge pattern. It is then converted directly to a video signal for transmission to the ground. Readout can be accomplished at different speeds to compensate for various power and band-width requirements dictated by the nature of the space mission.

The flexibility of the system permits readout of the same image numerous times, if desired, by ground control. In the laboratory, the same image has been read out up to 100 times without serious degradation of quality. Yet, the image is erased completely, with no trace of "sticking," as the tape is flooded with electrons prior to exposure. Transistorization of the package results in minimum weight and low power requirements.

Since a high vacuum is essential to the operation of a photo-dielectric tape camera system, it is "at home" in the harsh environment of space. Also, dielectric tape is virtually unaffected by radiation thereby eliminating this hazard to ordinary photographic film. It is also reusable and serves as its own storage medium for remote picture-taking sequences.

To find out how RCA's new photo-dielectric tape camera developments can fill your requirements for space image-sensing systems, write to the Manager, Marketing, Astro-Electronics Division, Defense Electronic Products, Radio Corporation of America, Princeton, New Jersey.

And for a challenging, rewarding career in electro-optical systems development, apply to the Employment Manager, RCA Space Center, Princeton, New Jersey. All qualified candidates are considered regardless of race, creed, color or national origin.

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Big GE Solar Power System Tested

THE LARGEST solar thermionic power system reported in the U.S. is functioning in a new General Electric Co. solar test facility outside of Phoenix, Ariz.

The unit has a potential efficiency of 15 to 20% of the total solar energy input. Early tests resulted in an output of 12.18 watts, but indicated design improvement areas. GE engineers believe a system can be designed which will produce as much as a kilowatt for each 100 lbs. of weight.

The system has no moving parts. An ideal solar thermionic unit would have this advantage plus light weight and more efficiency than other direct conversion power systems, such as thermoelectric devices.

Main parts of the system include a 195-sq.-ft. solar collector measuring 15.75 ft. across. The collector folds into a 12-ft.-dia. package when its petals are compacted. The decahedron generator has 105 thermionic vacuum converters and a switching system for light and dark periods.

The overall system includes a solar orientation unit, a power regulator which maintains output voltages between 26 and 29 volts, and a storage system consisting of a nickel-cadmium battery with 23 cells.

The vacuum thermionic converters are capable of 1.5 watts at 2.65% efficiency. More efficient converters using cesium vapors have been developed and may be used in future tests.

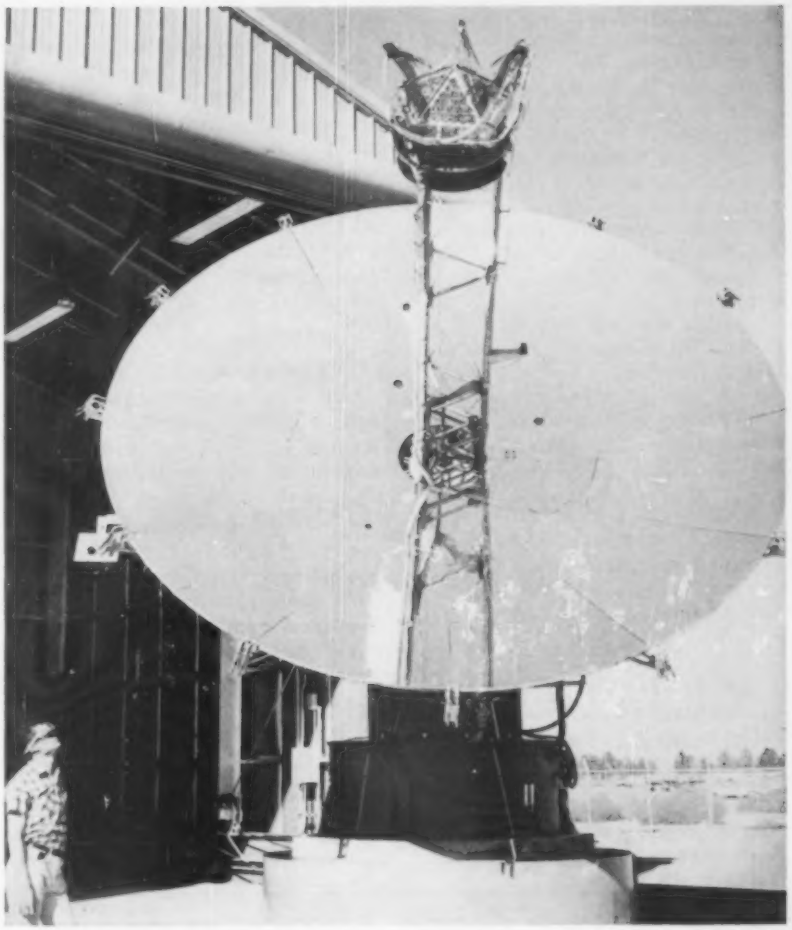
The more advanced vapor types may give as high as 25% efficiency. The current barium-strontium oxide-coated converters were built by GE. Temperatures up to 1150°C with an average of 904°C were achieved on the cathode during operation.

The system is designed for use in manned spacecraft, lunar colonies and communication satellites.

• **New test site**—The new GE solar thermionic power package was the first device to undergo tests at the company's recently completed solar test facility.

The main test building is 61 ft. long, 34 ft. wide, and 36 ft. high. A 41-ft. section of this building is mounted on 80 ft. of steel rails and is mobile and self-propelled, to permit rapid exposure of the solar mirror and associated equipment to the sun.

The two-axis tracking platform contained in the main test area can support loads up to 30,000 ft.-lbs., and is controlled to within 3 minutes of arc by a solar-sensing network. A manual override control is also available.



SOLAR COLLECTOR in GE's system is 15.75 feet in diameter, folding into 12-ft.-dia. package. Decahedron generator has 105 thermionic vacuum converters.

Supporting the main test area are a 400-sq.-ft. control and auxiliary equipment area and a complete weather station to determine test input parameters.

• **EHD device** — GE scientists in Philadelphia also announced successful testing of a device which produces electrical power using "electrohydrodynamics." A net output of 1.4 milliwatts at 170 volts with an input of only 0.1 milliwatts was achieved.

In an experimental generator, air was forced through a corona discharge field and ionized. As a result, electrons were drawn off in the area of the field, while ions were pushed downstream by neutral atoms to a collecting grid where they were re-combined with the electrons. The flow of electrons from the corona through a circuit to a collecting grid constitutes an electric current.

A small amount of power was supplied to the corona ring as exciter. The experiments showed that as the velocity of the air increased—causing more electricity to be generated—the amount of externally-supplied electricity became replaced.

GE spokesmen say the art in EHD is too elementary to predict ultimate advantages and limitations. ⌗

Ford-Philco Merger Wins Final Approval

THE FORD Motor Co. last week acquired the Philco Corp., strengthening Ford's bid for a larger slice of missile/space business.

Philco will retain its own name and will operate as a subsidiary of Ford, within the general products group.

It will be headed by Charles E. Beck, Ford's former director of business planning, who said the acquisition "puts Ford in a position to do a better job in the Government contract area." But Beck said there are no plans at present to merge the Aeronutronic division with Philco.

Earlier this year, (M/R, Sept. 25, p. 17) Ford President John Dykstra said his company is "moving into the defense and space business with both feet. We are determined to be in the vanguard of our country's effort to regain Space Age leadership."

CONTROL DATA CORP. opened a West Coast Computer Applications Center at Palo Alto, Calif., to provide computer time, contract programing and maintenance services for Control Data equipment.

INFRARED INDUSTRIES, INC. has formed a new unit to design satellite payloads capable of withstanding Van Allen Belt radiation. Electro-Nuclear Laboratories, Inc., will engage in radiation research using a 2-million-electron-volt particle accelerator. ENL headquarters will be at Mountain View, Calif.

COLLINS RADIO broke ground for an addition to its Components Division, Santa Ana, Calif. The expansion will double the size of the present facility

GULTON INDUSTRIES, INC., has acquired Rustrak Instrument Co., Inc., Manchester, N.H., and Continental Wire Corp., Wallingford, Conn. Rustrak makes recording and indicating instruments used in industrial controls, medical, military and other fields.

Continental will soon begin production of small high-temperature, low-noise coaxial cables for the missile industry.

GOODYEAR AIRCRAFT CORP. established a new space systems engineering division to handle design of manned and unmanned space, re-entry and launch vehicles and their support equipment.

The company also created an aeromechanics technology division for development of space materials, including those for expandable structures, aerodynamics, thermodynamics, structural stress analysis, structural dynamics and weight control, along with test operations and instrumentation.

An advanced technology division has been set up to handle all advanced weapon system design, including tactical missiles and underseas warfare studies. A life science group will study basic space vehicle environmental problems.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Bowmar Instrument Corp.	Year, Sept. 30	$ 6,417,391	$ 5,411,822	$ 386,785	$ 323,664
General Precision Equip. Corp.	9 Mo. Sept. 30	171,196,090	176,554,550	4,189,000	3,622,000
Litton Industries, Inc.	3 Mo. Oct. 31	73,000,000	52,111,000	3,425,000	2,150,000
Marquardt, Corp.	40 Wks. Oct. 8	35,021,350	51,139,377	464,776	1,088,203
Microdot Inc.	Year, Sept. 30	5,296,485	2,976,800	297,617	153,786
Moog Servocontrols Inc.	3 Mo. Sept. 30	2,564,688	1,880,485	29,075	—131,223
Northrop Corp.	3 Mo. Oct. 29	74,541,000	62,028,000	2,033,000	2,042,000
Radiation Inc.	Year, Aug. 25	26,244,383	23,155,845	587,839	184,787
Servomechanisms, Inc.	9 Mo. Sept. 30	9,358,000	10,196,000	357,000	—771,000
Sperry Rand Corp.	6 Mo. Sept. 30	547,133,965	561,352,778	9,695,026	11,774,666
Varian Associates	Year, Sept. 30	57,987,817	46,482,031	2,803,866	2,861,886

AIR PRODUCTS AND CHEMICALS, INC. has opened a new oxygen-nitrogen production facility in Cleveland. The plant will produce some 600 tons per day of liquid and gaseous oxygen, nitrogen, argon and neon.

AMERICAN MACHINE AND FOUNDRY CO. opened a new environmental laboratory at Stamford, Conn. The facility will operate as a part of the Greenwich Engineering Division of AMF's Government Products Group.

The lab is being used to test components for *Minuteman* storage, erection and launching mechanisms. It will also be available for other AMF programs and for outside companies which require performance of a variety of environmental tests.

THE HALLICRAFTERS CO. acquired Manson Laboratories, Inc., Stamford, Conn. Manson sales are mainly in military contracts. The company provides electronic R&D in the fields of military communications and high-power equipment.

UNITED AIRCRAFT CORP. is opening a systems center at Windsor Locks, Conn., to develop, manage and produce complex space, missile and other military systems. The Center will work with missile and space organizations other than United's divisions, as well as acting as the parent company's systems organization.

United also established a Solid Rocket Division in California to provide a framework for volume production of solid-propellant rocket motors. The division will support the activity of United Technology Corp.

AERO-FLOW DYNAMICS, INC. is the new name for Aero Supply Mfg. Co., Inc., Corry, Pa. and Linden, N.J.

ETS-HOKIN & GALVAN, INC. formed a West Coast subsidiary, the Technical Construction Co. TECON will be principally engaged in mechanical construction and installation projects at missile bases, other military sites and factories.

DAMON ENGINEERING, INC. has been formed in Needham Heights, Mass. The electronics company will produce quartz crystal filters, oscillators and other frequency selection and control systems and custom-built systems for spectrum analysis and telemetry.

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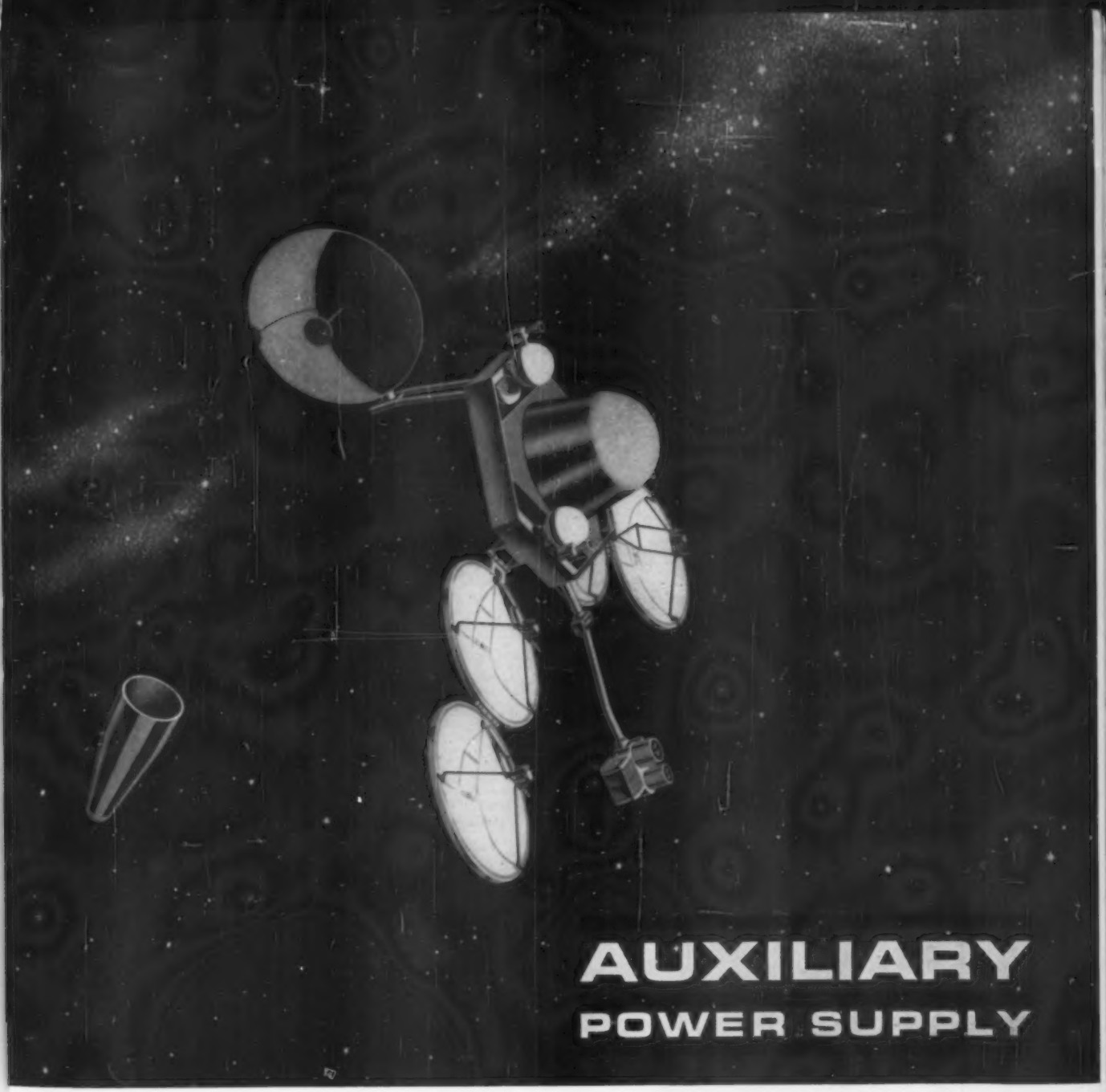

AUXILIARY POWER SUPPLY

Direct conversion of heat to electricity offers the solution to the problems of auxiliary power in space.

New techniques of space charge neutralization are being developed at Ford Instrument Company under U.S. Air Force, U.S. Navy and company sponsored studies. This work offers the opportunity to obtain significant power densities with wide spaced plasma power diodes at cathode temperatures around 1200°C. Application studies currently being undertaken involve chemical, solar and nuclear heat sources. I.e

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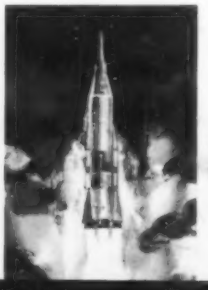

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Cape Complex 37

(Continued from page 25)

which top the gantry have hook capacities of 10, 40, and 60 tons for assembly of booster stages.

Two gantry support buildings, one of 12,500 sq. ft. and another of 2500 sq. ft., are built into the structure and move with it. These house support shops, hoisting units, and electrical control systems. Side panels of these buildings are of blowout design as protection against blast from adjacent areas.

Fixed platform levels and adjustable service platforms enable convenient assembly of the vehicle. All levels are served by two high-speed elevators.

Aluminum and 100,000-psi steel are the predominant materials in the basic gantry structure and the hinged vehicle enclosures.

The service gantry, which can move along standard-gauge steel rails at speeds up to 40 fpm or as slow as 1½ fpm, is powered by variable speed ac drives which supply traction to 32 of the 48 3-ft.-diameter wheels. A 1000-kva substation aboard the gantry supplies electrical power needs.

When the movable gantry is at its operational position alongside the launch site, the load is removed from the wheels by hydraulic equalizer rams and the structure is lowered to the foundation anchor assemblies and locked in place. The process is reversed prior to moving the service structure; the entire unit is lifted about 3 in. from the ground, and load is reapplied to the wheels.

• **Design problems**—The physical location of the new vertical launch facility at the Cape presented several early engineering problems, according to the consulting architectural and engineering firms.

The north end of the Canaveral complex has considerable marsh land which meant extensive site preparation. Soil in the immediate vicinity of the service structure anchors, launch control center, and pedestal was predominantly medium to fine sand which had to be consolidated to near-maximum density to withstand the anticipated severe vibrations of missile launch. A vibro-floatation method was used for this earth compacting job.

Heavy electrical load requirements for the new complex also demanded extension of transmission lines from southern portions of the Cape and installation of a new substation.

Also, the large volume of water necessary for fire protection required the construction of a 1 million gal. storage reservoir and pumping network (30,000 gpm). ⌗

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INDEX

ISSUES OF JULY 3, 1961 THROUGH DECEMBER 18, 1961

At the end of each six-month period, MISSILES AND ROCKETS *publishes an easy-to-find listing of major news and technical articles carried by the magazine. Note that because M/R publishes 51 times a year, every week except the last week in December, the current index covers 25 issues.*

A

ABLATIVE MATERIALS. OFF THE LOOM: ROCKET ABLATIVE MATERIAL, *8/7/61, p. 26.*

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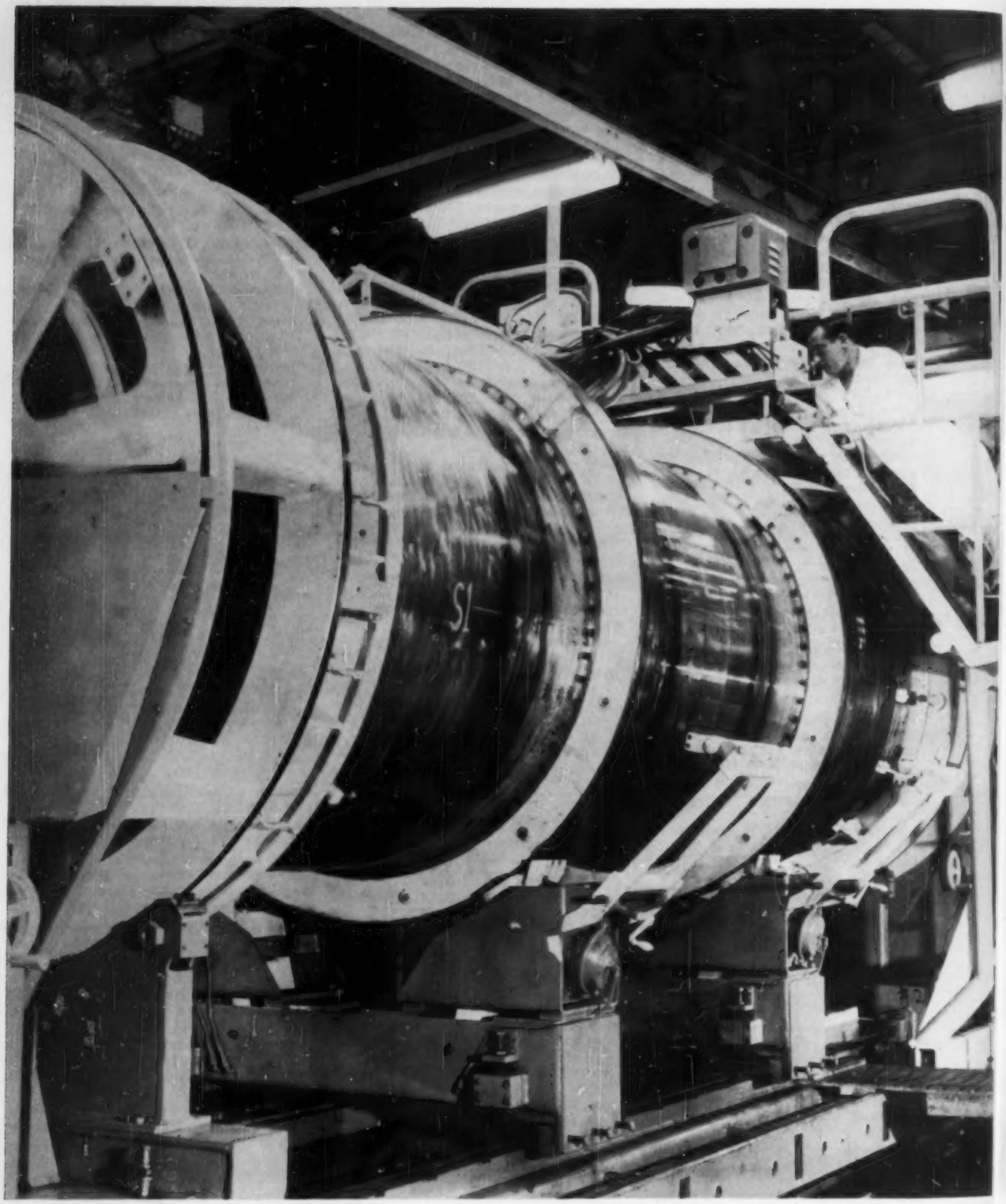
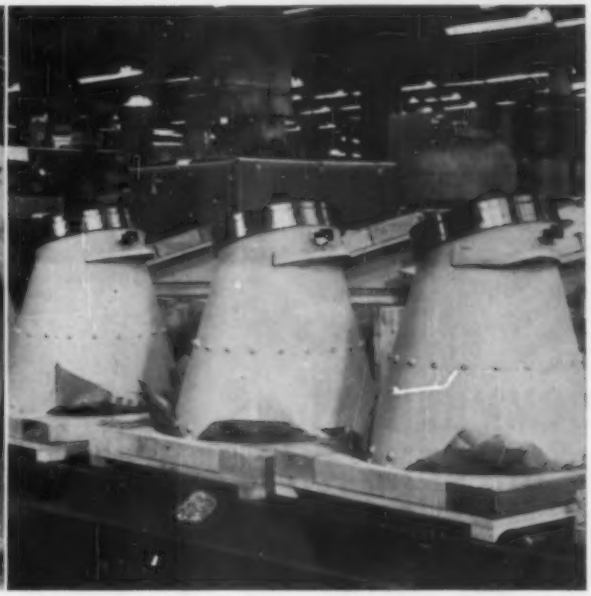
Sophisticated Skills of Curtiss-Wright .....



Fabrication of a flight quality first stage rocket motor case for a U. S. Air Force Minuteman missile at Wright Aeronautical Division. These huge cases are fabricated to extremely close tolerance from high strength alloy steel.

Missile Manufacturing Technology

Precision machining of missile aft closure for U. S. Army Pershing missile.



Rotating rocket nozzle assembly line for U. S. Navy Polaris missile.

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Technological advances in rocket case manufacture include development and application of shear spinning and alloy research in titanium, 20-25 per cent nickel, beryllium and vacuum-melt alloys. Today's techniques, facilities, and sophisticated production skills furnish ultra-precision control in fabricating close tolerance rocket motor cases — high in quality . . . exceptional in reliability.

Similarly, in nozzle research, design and manufacture, new metallic and non-metallic materials and advanced developments in fabrication and liquid cooling technique, provide flexibility and imagination for future nozzle production.

Wright Aeronautical's vast experience and facilities provide a broad capability to handle programs combining management, scientific engineering and production skills in today's dynamic aerospace industry . . . and resources to meet tomorrow's challenges.

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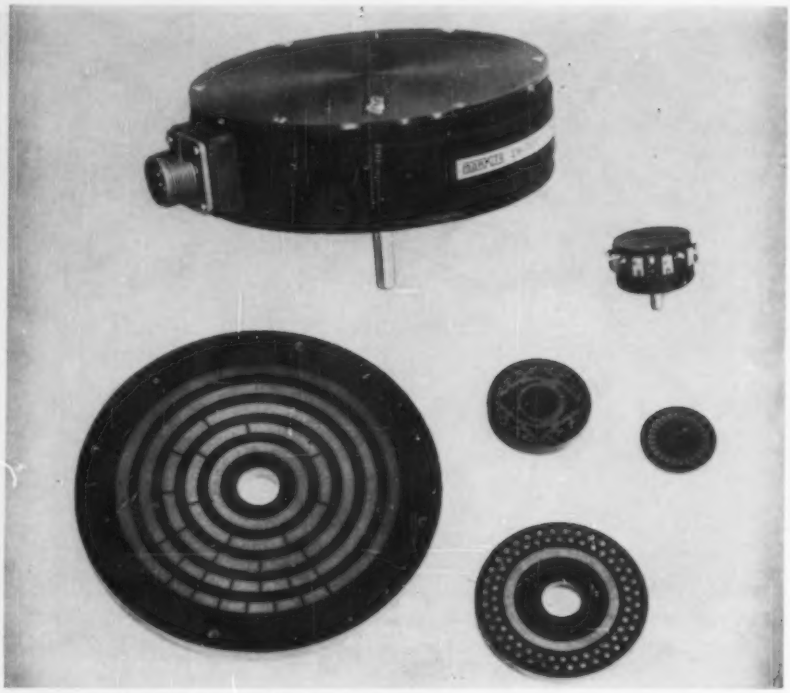


New Product of the Week:

Conductive Plastic Switches

A LINE OF precision rotary switches for aircraft and missile controls and instrumentation is available from Markite Corp.

The Markite switches, which incorporate completely molded and flush switch plates, have the advantages of hard, smooth switch plate surface, no stick-slip of wiper, long wear-life and resistance to high-g environments.

Each unit is integrally molded and each plate embodies sections of Markite conductive plastic of high conductivity, with insert-molded terminals, molded to the plastic insulator base.

Markite switches are designed for sampling, telemetering, programing, remote control and signaling, signal distribution, and square-wave generation.

Circle No. 225 on Subscriber Service Card

Rocket Insulation

A light, low-cost, ambient-curing thixotropic insulation which can be sprayed on as rapidly as 40 lbs. per hour is available from Insulation Technology, Inc. The firm is also marketing a trowelable thixotropic rocket insulation formulated especially for use on rocket engines.

The sprayable insulation, a 100% solid organic compound containing no solvents, has a specific gravity of only 1.19. Any desired thickness can be sprayed without sag or slump on vertical surfaces with no waiting between coats, as with solvent dispersed materials. Its ambient temperature cure allows use on live motors.

The company's sprayable insulation, NRL 1126, has 25% elongation; trowelable insulation is more rigid, with a 5% elongation. Samples 0.25-in. thick of each material, tested under erosive burning conditions with an oxyacetylene torch for 60 seconds, show a 20°F rise in back side temperature for the sprayable compound, and only 5°F for the trowelable rocket motor insulation material (NRL 1795).

Circle No. 226 on Subscriber Service Card

DC Power Supply

A high-stability, high-voltage d-c power supply featuring stability of 0.005% per hour, 0.02% for an 8-hr. period, is available from NJE Corp. Designated the HSV-5-20, it has an output of 50 to 5000 V and 0-20 MA. Input power is 105-125 V at a frequency of 55-65 cycles. Maximum ripple (mv) is 5 P-P. Static regulation is 0.01% maximum load for no-load to

full-load change at constant voltage, and 0.01% maximum line for line voltage change of 105-125 V AC at any constant load from zero to full load of rating.

Circle No. 227 on Subscriber Service Card

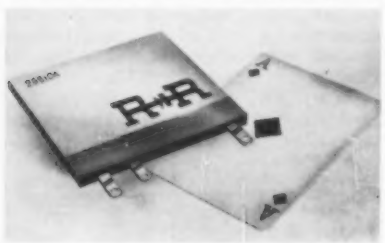
Incremental Gaussmeter

An incremental gaussmeter, Bell Model 240, which uses a single Hall Effect sensing element and can be inserted in gaps only .020 in. long, is available from F. W. Bell, Inc. It combines all the features and capabilities of an earlier model, the Bell Model 120, while adding the advantages of incremental reading. The model will operate both as a conventional flux measuring and plotting instrument and as an expanded-scale, suppressed zero meter for observing small changes, or increments, in flux density. By means of a controlled feedback system, it can magnify a small change by a factor of 100 or more for detail study.

Circle No. 228 on Subscriber Service Card

Selenium Rectifiers

To its recently announced line of flat, conduction-cooled selenium rectifiers, Radio Receptor Co., Inc. has added a line of "power flats" with similar advantages in applications requiring power-handling capacities up to 250 volt-amperes or even higher. Currently



available units include half-wave, doubler, and bridge configurations in single-phase or 3-phase circuits, in a single package for voltages up to 130 volts rms input and current outputs to 10 amperes dc., based on an allowable case-temperature of 150°F.

Circle No. 229 on Subscriber Service Card

Precision Thermostat

A subminiature snap-acting thermal switch is available from Thermel, Inc. Hermetically sealed, and especially resistant to vibration, shock and salt spray, this precision unit (Thermel #3001-2) meets or surpasses all applicable military specifications. Creeping and false cycling has been eliminated by an instantaneous "make and break" action. Insulation between the bi-metal disc and electrical contact arm insures control response from ambient temperatures only.

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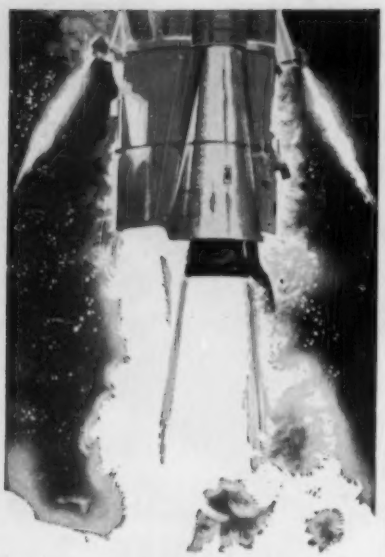

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names in the news

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Otto G. Quanrud: Former director of control and guidance at Rome Air Development Center and more recently with Pan American World Airways' Advance Planning Department, has been named assistant manager of Pan Am's newly created engineering management section called the Manned Lunar Landing Program. The section will direct and control the company's support of the Air Force Missile Test Center and NASA in development of the lunar launch range and conduct of operational phases.

Willion G. Fallon, Jr.: With Norton Company since 1943, rising to vice president and director in 1958, has been named vice president and general manager of Norton International Inc., the company's foreign operating subsidiary. **Allan F. Hardy, Jr.,** succeeds Fallon as general manager of Norton Company's Refractories Division. Also, **Louis J. Camarra** has been appointed vice president in charge of Latin American operations. He was formerly Norton International's vice president in charge of sales of abrasive products. These appointments follow by a week the announcement that **Dr. Wilfred F. L. Place** had been named vice president in charge of European operations for Norton International.

Lt. Gen. Roscoe C. Wilson (USAF-Ret.): Recently retired AF research chief, has been elected president and a director of Allied Research Associates, Inc. (M/R, Dec. 11, p. 12). Also elected to the board of directors were **Maj. Gen. Frederick L. Anderson, (USAF-Ret.), Paul V. Cusick, Henry W. Harding, William Barclay Harding, Donald L. Lucas, Lt. Gen. Donald L. Putt (USAF-Ret.),** and **Milo Vesel. Norman Buchbinder,** vice president-finance and administration, also is a director of the firm.

Arthur C. Omberg: Elected a vice president of the Bendix Corporation, responsible for operating three divisions—Bendix Mishawaka, Ind., Bendix Products Aerospace, South Bend, Ind., and Bendix Hamilton, Ohio—in addition to continuing to serve as general manager of the Mishawaka division. Omberg joined Bendix in 1944 as chief of research engineering.

Paul G. Hensel: The inventor and developer of the Doppler direction finders and the Doppler omnirange equipments has joined Electronic Communications, Inc., as vice president of engineering. Hansel has been associated with Servo Corporation of America and with the Signal Corps Engineering Laboratories.

Martin E. Zernick: Appointed president of NYT Manufacturing Co., Alpha, N.J. Prior to joining the organization in 1958 as vice president of manufacturing, he was associated with General Electric Co. in various management capacities.

Frank J. Skwarek: Former vice president of Polarad Electronics Corporation's Defense Products Division, will head the new Electronic Systems Division covering research and development in such areas as electronic countermeasures systems, space navigation and communications equipment, precision instrumentation systems, antisubmarine warfare systems, aerospace ground support systems, and radio interference instrumentation. Prior to his present position, Skwarek was associated with General Electric Co., Westinghouse Electric Manufacturing Co., Sperry Gyroscope Co., Doelcam Corp., and Raytheon Manufacturing Co. He joined Polarad Electronics in 1951.

Vern E. Leas: Appointed director of military program management for the Univac Military department, Sperry Rand Corp. He will direct and supervise all major military programs at St. Paul-Univac, including computers for the *Titan, Nike-Zeus,* Naval Tactical Data System, Mobile Atlantic Range Station and advanced digital computer for aerospace applications. Leas had worked for IBM and as a self-employed electrical contractor prior to joining Univac.

Robert E. Steinman: Succeeding the late **Dr. S. Jacobsohn,** named president and elected to the board of directors of Gaertner Scientific Corporation. Steinman joined Gaertner in 1960 as administrative vice president. Previously, he was with Charles Bruning Co., Inc.

Robert C. Loomis: Formerly president of the Convair-San Diego division of General Dynamics Corporation, has joined American Electronics, Inc., as president and chief executive officer. Loomis will be in full charge of the company's multi-division operations located in Fullerton and Culver City, Calif.

—contracts—

AIR FORCE

$19,962,250—**General Dynamics Corp.**, for production of space boosters.

$12,144,777—**The Martin Co.**, Denver, for research and development for the *Titan II* program.

$11,000,000—**Radio Corporation of America**, Moorestown, N.J., for work on the Ballistic Missile Early Warning System.

$7,500,000—**Massachusetts Institute of Technology**, Cambridge, for work on a jointly-sponsored Air Force-Army-Navy-ARPA contract for performance of research and development in national defense.

$6,000,000—**Space Technology Laboratories, Inc.**, Los Angeles, for systems engineering and technical direction for the *Atlas*, *Titan* and *Minuteman* weapon systems.

$5,000,000—**Aerojet-General Corp.**, Sacramento, Calif., for research, development and related work for *Minuteman* motors (supplemental contract).

$5,000,000—**Page, River and Curran**, Washington, for installation and checkout of the *Minuteman* control system at Ellsworth AFB, S.C.

$4,495,132—**American Bosch Arma Corp.**, for fabrication of missile guidance sets and related items and for installation and a checkout of the *Atlas* guidance system. (3 contracts)

$4,000,000—**Federal Electric Corp.**, Paramus, N.J., for installation of an interim tropospheric scatter communication system.

$3,900,000—**The Martin Co.**, Denver, for fabrication of *Titan II* missiles.

ARMY

$8,000,000—**General Electric Co.**, Philadelphia, for work on Project *Advent* communication satellite vehicle.

$5,000,000—**Radio Corp. of America**, for continuation of Project *DAMP*.

$3,642,000—**Raytheon Co.**, Lexington, Mass., for *Hawk* missiles and 21 maintenance test shots for the system (2 contracts).

$1,800,000—**Western Electric Co.**, Greensboro, N.C., for production of ground control equipment for *Nike-Hercules* missiles.

$1,470,487—**Pearce and Greshan**, Decatur, Ala., for static-test facility for the *Saturn* vehicle.

MISCELLANEOUS

$15,000,000—to **Vitroselenia**, Italian company owned by **Vitro Corp. of America** and **Selenia S.p.A.**, a **Raytheon Company** subsidiary in Italy, for design and management of installation of a missile test range on the island of Sardinia.

$5,500,000—**Arde-Portland, Inc.**, Paramus, N.J., from **Thiokol Chemical Corp.**, for thrust vector control nozzles for first stage of *Minuteman* ICBM.

NAVY

$10,000,000—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for *Polaris* motors.

$4,493,561—**Hercules Powder Co.**, Wilmington, Del., for research and development in solid propellants.

$4,000,000—**Minneapolis-Honeywell's Aeronautical Division**, St. Petersburg, Fla., for reference and pendulous gyroscopes for the *Polaris* guidance system.

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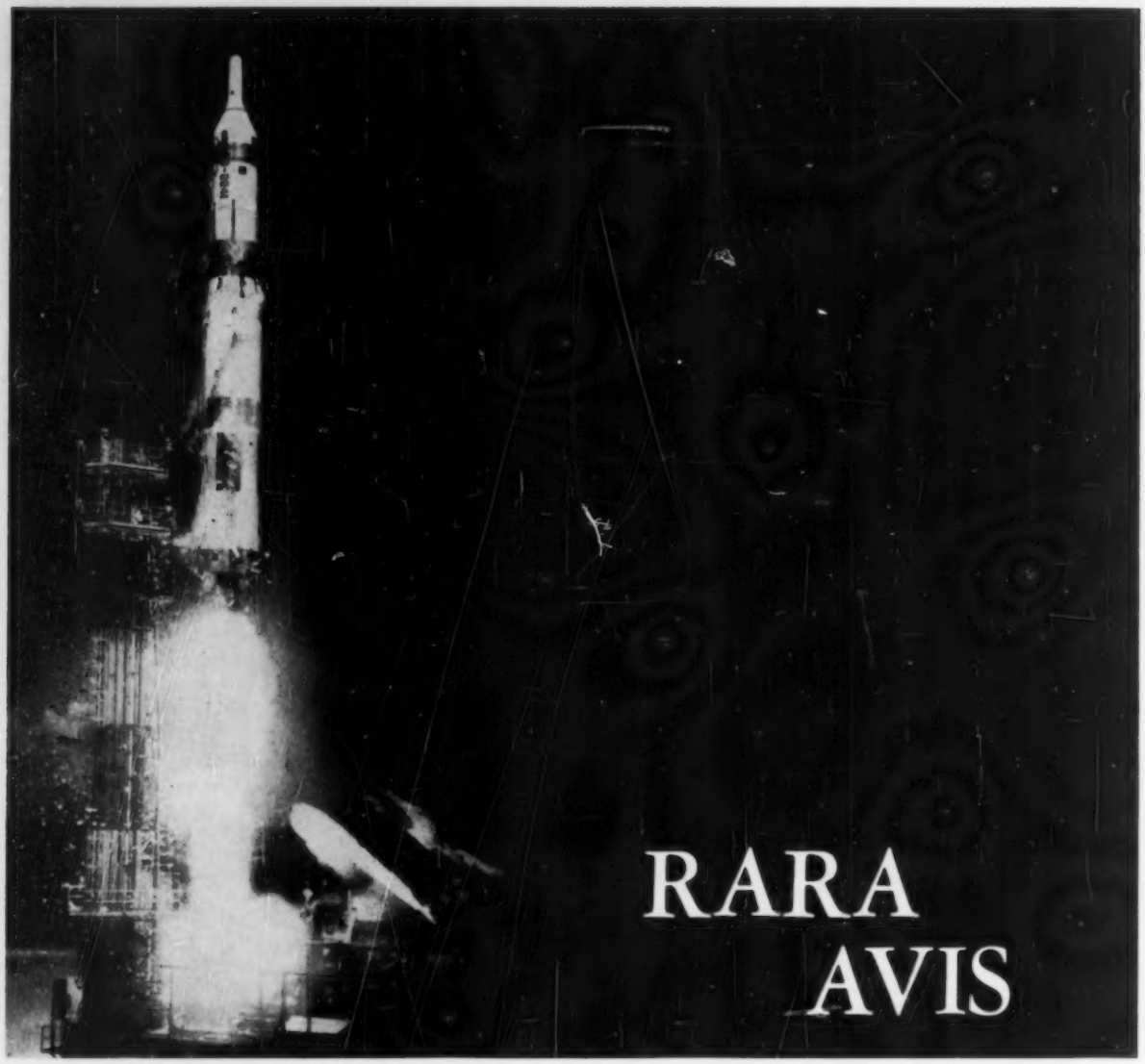

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MISSILES AND ROCKETS
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RESEARCH AND ENGINEERING ISSUE

theme: MILITARY SPACE SYSTEMS

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when and where

DECEMBER

Wright Brothers Lecture, sponsored by Institute of the Aerospace Sciences, Smithsonian Institution, Washington, D.C., Dec. 18.

Annual Meeting, American Association for Advancement of Science, Denver, Dec. 26-31.

Annual Meeting, American Statistical Association, Roosevelt Hotel, New York City, Dec. 27-30.

JANUARY

Automotive Engineering Congress and Exposition, sponsored by Automotive Engineers, Inc., Cobo Hall, Detroit, Jan. 8-12.

8th Annual Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

1962 Business Outlook Conference, sponsored by the Los Angeles Chamber of Commerce, Biltmore Hotel, Jan. 10.

30th Annual Meeting, Institute of the Aerospace Sciences, Hotel Astor, New York City, Jan. 22-24.

National Plant Engineering and Maintenance Show and Conference, Convention Hall, Philadelphia, Jan. 22-25.

Solid Propellant Rocket Conference, ARS, Baylor University, Waco, Tex., Jan. 24-26.

American Society of Mechanical Engineers, 2nd Symposium on Thermo-Physical Properties, Princeton, N.J., Jan. 24-26.

FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Las Vegas, Nev., and Los Angeles, Feb. 3-11.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, San Francisco, Feb. 19-21.

30th Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, Symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, Mar. 13-14.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16. (Goddard Memorial Dinner on Mar. 16.)

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A Letter From the Editor

YEAR'S END provides a good opportunity to look back at the accomplishments of the missile/space industry during 1961 and ahead at its prospects and problems for 1962.

The industry can take pride in its achievements during a year in which a considerable head of pressure built up in regard to both manned and unmanned space flight programs, as well as the military programs for intercontinental and shorter-range missiles.

The year will go into the record books as the one in which the Russians, and the Russians alone, succeeded in placing men in earth orbit. We compliment the President and the National Aeronautics and Space Administration for the excellent sense shown in deciding not to pressure the Project *Mercury* team into a manned orbital flight attempt before year's end.

This magazine pointed out as early as July 24 that the manned orbital shot was almost certain to slip into 1962. Sound technical reasons existed for this. Any effort to high-pressure the program into a manned orbital shot in 1961 just to get it on the books in the same year as the Russians would have been a foolhardy and unnecessary risk.

The wonderful successes of the Shephard-Grissom suborbital *Mercury* flights and the initial *Saturn* firing made the year an outstanding one in the U.S. space program. With still a long way to go, we now are back in the race with the Russians with the avowed intent of catching and passing them. The year must be recorded as one in which our national leadership, for the first time, displayed the heartening support needed in the space race.

Letting of the prime *Apollo* contract was a major milestone in our developing space effort. At the beginning of the year, when another publication attacked the appointment of James E. Webb as NASA Administrator, we announced that we would withhold judgment on Mr. Webb until he had the opportunity to prove himself. NASA has expanded this year at a fantastic rate, as new responsibilities were heaped upon it by the President. Earlier in the year, as we reported, this resulted in considerable confusion in the space agency. Organization now is coming out of that chaos. Top-level NASA appointments have been sound, and the reorganized agency shows promise of being able to cope with the important tasks assigned to it. We think Mr. Webb is doing a good job in a difficult post.

Frequently overlooked but no less important than the more widely publicized manned space efforts are the growing number of unmanned scientific space probes and satellites. The year was an outstanding one in that respect. The *Discoverer* program continues on its successful path, *Scout* shots are mounting in frequency, and the weather satellites already have proved their value.

The missile program moved well in 1961 and the Missile Gap—which many seem to have forgotten still exists in potential—shows signs of being closed under firm Department of Defense policy decisions.

The year 1961 also may turn out to be the one in which the dizzy spiral of "technical" meetings, association banquets and conventions finally reached its apogee. Our editorial stand for fewer, less extravagant and more worthwhile meetings drew an overwhelmingly favorable response from all parts of the industry and was followed by expressions of support from our colleagues on other trade magazines.

The recent action of Aerospace Industries Association in requesting its members to screen attendance of their employees at meetings, to set a high quality standard for reports, and to avoid costly exhibits could be a significant turning point. We applaud the AIA stand and urge the strongest possible industry support.

At the same time, we agree with AIA in its expression of support for strong technical and scientific societies. In this regard, we are quite pleased by the growing strength of the American Rocket Society, which enrolled its 20,000th member during 1961. Our compliments and best wishes for an even more successful 1962.

LARGE PROBLEMS—in the patent field, in procurement practices and in obtaining recognition and financial support of important technical advances —lie ahead in 1962. We will keep attention focused on these.

We cannot state strongly enough our belief that a major military space effort must be initiated in the year ahead. The first step in this direction must be a well-financed expansion of the *Dyna-Soar* program. Military programs aimed at space reconnaissance and interception also need support. The industry must make every effort to convince Congress and the Administration of the importance to the nation of these programs.

In 1962, the U.S. will for the first time send a man into earth orbit. It will be a year in which we should not let our successes blind us or our setbacks discourage us. Overall, it should be, as the saying goes, a banner year for the missile/space industry.

In conclusion, we would like to add, from all of us on MISSILES AND ROCKETS to all of you, another old saying: Best wishes for a very Merry Christmas and a peaceful, Happy New Year.

William J. Coughlin

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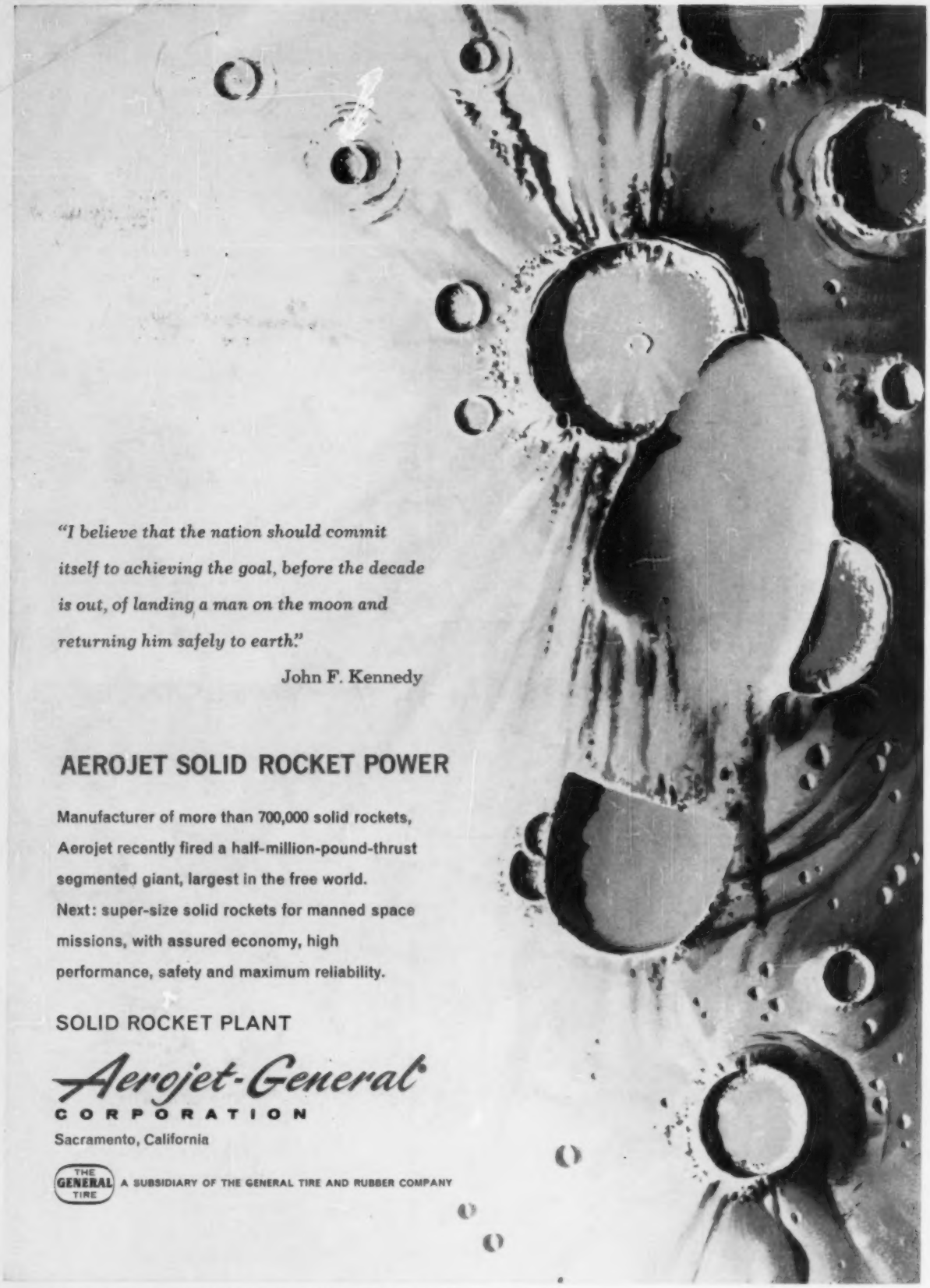

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